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FINAL

National Petroleum Reserve-Alaska
Integrated Activity Plan Environmental Impact Statement
Volume 2: Chapter 4 (Sections 4.1-4.4)

U.S. Department of the Interior
Bureau of Land Management

BLM

Alaska

The Bureau of Land Management Today

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To enhance the quality of life for all citizens through the balanced stewardship of America's public lands and resources.

Our Mission

To sustain the health, diversity, and productivity of the public lands for the use and enjoyment of present and future generations.

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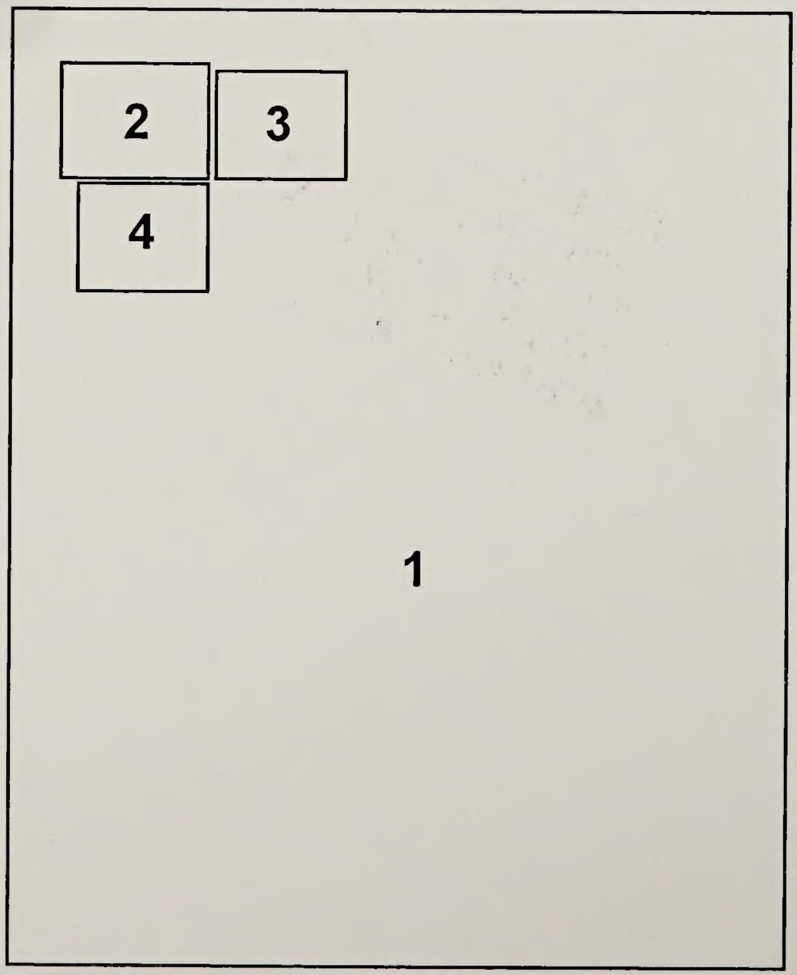

Cover Photos:

1. Along the Archimedes Ridge in the Utukok River Uplands of the National Petroleum Reserve-Alaska. © Patrick Endres

2. Winter petroleum exploration, National Petroleum Reserve-Alaska. Photo by NSSI

3. Polar Bear, North Slope, Alaska.

4. Two newly born caribou calves in the Utukok River Uplands of the National Petroleum Reserve-Alaska. © Patrick Endres

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National Petroleum Reserve-Alaska

FINAL

Integrated Activity Plan/ Environmental Impact Statement

Volume 2

Chapter 4 (sections 4.1 to 4.4)

Prepared by:

U.S. Department of the Interior
Bureau of Land Management
Anchorage, Alaska

In cooperation with:

North Slope Borough
U.S. Bureau of Ocean Energy Management
U.S. Fish and Wildlife Service

November 2012

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How the IAP/EIS is Organized

VOLUME 1

Chapter 1 – Introduction: Summarizes the purpose of and need for this IAP/EIS and decisions to be made.

Chapter 2 – Alternatives: Describes and compares proposed management alternatives.

Chapter 3 – Affected Environment: Presents existing natural and socioeconomic resources in the NPR-A and trends, including those associated with climate change.

VOLUME 2

Chapter 4 – Environmental Consequences (sections 4.1 – 4.4): Provides the assumptions upon which the impact analysis rests and evaluates impacts of Alternatives A and B-1 on resources and uses in the NPR-A relevant to making a decision among the alternatives.

VOLUME 3

Chapter 4 – Environmental Consequences continued (sections 4.5 – 4.7): Evaluates impacts of Alternatives B-2 (preferred alternative), C, and D on resources and uses in the NPR-A relevant to making a decision among the alternatives.

VOLUME 4

Chapter 4 – Environmental Consequences continued (sections 4.8 – 4.13): Evaluates the cumulative impacts on resources and uses in the NPR-A and other effects relevant to making a decision among the alternatives.

VOLUME 5

Chapter 5 – Consultation and Coordination: Describes public and government (including tribal) consultation undertaken for this plan and the development of alternatives and lists the plan's preparers.

Chapter 6 – Comments and Responses: Presents public comments on the Draft IAP/EIS and responses to the comments.

VOLUME 6

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Section 4:

Environmental Consequences

CHAPTER 4: ENVIRONMENTAL CONSEQUENCES

4.1 Introduction

Chapter 4 examines how authorized activities, including oil and gas exploration, development, operation, and abandonment and non-oil and gas activities, may impact the physical environment, biological resources, and social systems in the NPR-A under each of the alternatives described in Chapter 2. Section 4.2 describes the assumptions the BLM makes on what activities may occur in the NPR-A in the future under the various alternatives, while subsequent sections provide the following types of impact analysis:

- Direct and indirect impacts - see sections 4.3, 4.4, 4.5, 4.5, and 4.7.
- Cumulative impacts - see section 4.8.
- Unavoidable adverse commitments - see section 4.9.
- Relationship between the local short-term uses and maintenance and enhancement of long-term productivity - see section 4.10.
- Irreversible and irretrievable commitment of resources - see section 4.11.
- Low-probability, very large oil spill - see section 4.12.

A summary of the relative degree of predicted effects for each resource was provided in Volume 1, Chapter 2, Table 2–3. All effects disclosed in this chapter and in Table 2–3 assume that there would be compliance with the direction provided by lease stipulations and required operating procedures/best management practices identified in Chapter 2.

The analyses of environmental consequences in this chapter build upon the alternatives described in Chapter 2 and the description of the affected environment provided in Chapter 3. Each of the alternatives includes protective measures in the form of lease stipulations and required operating procedures/best management practices. There are also North Slope Borough, State, and federal agency (e.g., U.S. Fish and Wildlife Service, EPA) regulations that govern activities in the planning area. For example, there are State and federal requirements that operators must have approved oil spill contingency plans. There are also State regulations that prohibit the harassment of wildlife by use of aircraft, snow machines, or boats (5 Alaska Administrative Code). In addition, this chapter identifies some additional "mitigation measures," as the term is used in the BLM's NEPA Handbook (page 61), that may further reduce impacts. These mitigation measures are not part of the alternatives. Rather they are suggestions of additional means to lessen impacts that are identified in the impact analysis. Some may not be within the BLM's authority to implement and thus would require the involvement of other agencies to execute them. These mitigation measures, along with a description of their effectiveness to mitigate impacts as well as the impacts these measures may themselves create, are included to allow for public consideration and comment. The BLM's record of decision will identify which mitigation measures identified in Chapter 4 the BLM will adopt.

The analysis of impacts in the Draft IAP/EIS as well as input from the public on the Draft IAP/EIS have helped guide BLM's development of the preferred alternative. As in any discussion of scientific evidence regarding the biological environment and human society, particularly when attempting to project what may happen far into the future, there is some uncertainty—sometimes substantial uncertainty. This IAP/EIS acknowledges that in some cases, especially in cases where scientists are still pursuing additional information and there is the greatest range of uncertainty about impacts, there may be substantial or significant impacts. However, the less than complete knowledge about future impacts and the wide range in some projected impacts is still sufficient to make a reasoned choice among the alternatives.

4.2 Basic Assumptions for the Environmental Consequences Assessment

4.2.1 Ground-impacting Management Actions

Ground-impacting management actions refer to activities managed through the BLM's regulatory and permitting processes. These activities could have some level of impact "on the ground" in the NPR-A. For this plan, ground-impacting activities have been divided into those not associated with oil and gas activities (addressed in section 4.2.1.1) and those that are associated with oil and gas activities (addressed in section 4.2.1.2).

4.2.1.1 Activities Not Associated With NPR-A Oil and Gas Exploration and Development

This section describes activities undertaken by the BLM or requiring BLM authorization that are not associated with NPR-A oil and gas exploration and development that could occur in the NPR-A, including their probable location, their anticipated frequency of occurrence, and the time of year in which they would likely take place. The anticipated extent of some of these activities under each of the alternatives is summarized in Table 4-1 on page 3. Measures to protect the environment that would be applied to BLM authorizations for non-oil and gas activities are presented in Tables 2–2 and 2–3 in Chapter 2, Volume 1. While some protections described in Table 2–2 apply directly to oil and gas activities, if a non-oil and gas activity would require similar on-the-ground actions posing similar environmental risks, the BLM may adapt the protections of the oil and gas-related measure.

Aircraft Use

Aircraft activity includes point-to-point transport of personnel or supplies and survey or monitoring activity. Most aircraft activity would take place during spring, summer, and fall. While it is likely that aircraft would fly over nearly all of the planning area, airspace over river drainages usually has the most activity for monitoring of wildlife and human use. Use of aircraft to complete cultural and paleontological surveys would most likely occur along river drainages and coastal areas. Aerial wildlife surveys would be most common during late June through July, over caribou and waterfowl habitat areas.

Watercraft Use

Watercraft would be allowed for summer transportation. Watercraft would likely be used by researchers during study efforts if facilities or areas of concern were located near large waterbodies such as the sea, rivers, or large, deepwater lakes. These activities would occur during the summer months, but the type of activities and their frequency and locations remain speculative because data quantifying these activities have not been collected for the planning area.

Excavation and Collection

Excavating and collecting archaeological, paleontological, geologic, and soil resources occurs mostly during the summer. Excavation usually is done using a trowel or hand shovel, is usually limited to areas of several square feet, and rarely extends more than three feet below the surface. Some excavations require heavy machinery and blasting, however (Alaska Report 2007[1]). If an archaeological site is studied in detail or if a geologic section is mapped, then larger areas might be excavated. Excavations are backfilled, and in most cases, the vegetative layer is replaced atop the excavation. Most excavation would probably occur within the primary drainages of the planning area.

Table 4-1. Summary of annual selected non-oil and gas related management activities

Activity	Frequency	Season
Aircraft use[1]		
Point-to-point	Up to daily	Mostly summer
Wildlife aerial surveys	Up to daily	Mostly summer
Other aerial surveys	Several 1- to 3-week periods	Spring, summer, fall
Watercraft use		
River trips[2]	Intermittent	Summer, fall
Excavation and collection		
Research/archeological	Up to 4-6 acres disturbed per year	Mostly summer
Ground activities and camps[3]		
Large camps[4]	3 to 4 camps/up to 12 weeks	Winter and summer
Small camps	20 or 30 small camps days to 12 weeks	Mostly summer
Overland moves	4 to 60 trips per year	Winter
Waste removal and remediation[5]		
Non-oil and gas		Winter and summer
Recreation and film permits		
Permits[6] issued	Typically 6 to 12 permits	Spring, summer, fall

1. This does not include use that is associated directly with oil and gas development within NPR-A. It also assumes that fixed-wing aircraft and helicopters are used and that use occurs almost exclusively during spring, summer, and fall. Pre-development research and monitoring associated with potential onshore facilities to support offshore develop in the Chukchi and Beaufort seas is discussed in "Pre-Development Research and Monitoring for Offshore Development" at the end of section 4.2.1.1.
2. Summer transportation and supply.
3. Camps in this category are not associated directly with oil and gas development.
4. Large camps are at least 15 persons and may have 5,000 gallons of fuel. Camps are likely to be located at Umiat, Lonely, Ivotuk, Inigok, and sites near the headwaters of the Kiligwa and Meade rivers.
5. Non-oil and gas operations include site evaluation and clean-up at former defense sites such as the Short Range Radar Site at Wainwright, or Point Barrow. This type of activity would probably decrease in frequency as these sites are cleaned up in the future.
6. Average of four to six persons per party.

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[1] http://alaskareport.com/news1007/do77849_dinosaurs.htm, website accessed September 22, 2011

Ground Activities and Camps

Ground activities include small groups of scientists, or recreationists (including guided hunting parties) hiking across tundra or floating down a river. Ground camps range from those supplied by aircraft to those with only a backpack's worth of supplies. Larger camps include a fuel tank or bladder of up to 5,000 gallons, or fuel in drums, and might have 20 or more people. Smaller parties use "fly" camps that are set up and moved every few days by boat, raft, or aircraft, and have nothing more than stove fuel. Backpack camps have even fewer supplies than fly camps and tend to move every day.

Small camps might be located throughout the planning area. Larger camps would most likely be placed at the Inigok airstrip, the Lonely DEW-Line site, and temporary camps on the Kiligwa River. A frequently used large camp at Ivotuk is approximately 9 miles outside of NPR-A. All of these camps would have fuel facilities, and fuel caches might be established at some other sites even if a camp were not present. Human waste at small temporary camps is disposed of as recommended in the National Outdoor Leadership School's Leave No Trace, Alaskan Tundra guidelines. Use of the Inigok airstrip and pad is likely to remain at current levels or increase slightly over the next few years to support management activities. The BLM may issue minimum-impact NPR-A permits that allow activities such as research and monitoring.

Overland Moves and Other Land Use Permits

The BLM issues minimum impact rights-of-way for overland moves to bring supplies to villages. Current management policy for the planning area allows only those activities that would have a negligible impact on the environment. Permafrost underlies the entire planning area, and wetlands cover the majority of the planning area. Due to the types of soils that exist in the NPR-A, the BLM does not issue permits for summer inter-village overland travel in the NPR-A. Vehicles allowed for use in overland moves would exert low ground pressure and be permitted to travel only over snow-covered ground frozen to a sufficient depth to minimize soil and vegetation impacts. Typically, overland moves would originate in Prudhoe Bay or Barrow and would utilize overland travel routes or sea ice. Streams are commonly crossed at dry streambeds, on grounded ice, or ice thick enough to support the crossing vehicles. Overland moves would typically begin in December when there is adequate snow cover and the ground is frozen and end in early May. On a yearly basis, from as few as 4 to as many as 60 trains of 4 to 15 vehicles and attached sleds could engage in overland travel. Should oil and gas exploratory drilling and development increase the amount of general activity on the North Slope, the number of overland moves would likely be closer to the high end of this range. The width of overland trails is approximately 12 feet.

The BLM may issue minimum-impact NPR-A permits that allow activities such as research and monitoring. Because of the fragile nature of thawed tundra during the summer, large camps are normally restricted to durable areas such as gravel bars, beaches, or existing gravel pads.

Solid and Hazardous Waste Removal and Remediation

Wastes, including those considered hazardous, are associated with human activity. A phased approach would be used to address hazardous and solid wastes in the planning area. This process would include verification and site evaluation of uncontrolled releases of hazardous substances on public land. The process for hazardous waste removal, described below, is consistent with guidance and regulations from the Comprehensive Environmental Response, Compensation, and Liability Act and National Contingency Plan.

Initial Incident/Site Examination

In response to a discovery that a hazardous substance has been released, or the threat of a release into the environment, trained personnel perform an initial incident/site examination, confirming the release and verifying land ownership. This inspection and verification of discovery information potentially requires the use of helicopter or fixed-wing aircraft to move personnel to the site. Time spent on these activities can vary from two weeks to several months at a site, but would depend on the number and types of reports or discoveries.

If the initial examination were to suspect or verify a release, a risk assessment would be completed to determine whether the situation posed an imminent threat to either public health or sensitive environments. If the situation warranted immediate action, an emergency response or removal action could be initiated.

Site Evaluation

If the initial examination verified that the release of a reportable quantity of a hazardous substance (as defined in 40 CFR § 302.4) occurred, a threat existed, or a release was suspected but the situation did not warrant an emergency response, a site evaluation would be conducted. The site evaluation process would be concurrent with identifying potential responsible parties. The responsible party, once identified, would complete, under federal and State oversight, all remaining evaluative and remedial actions.

The first step in the site evaluation is to document whether the released material is a hazardous substance and to identify the potential targets of impact. Collection of non-intrusive samples is often required. The site evaluation also determines the need for and appropriateness of removal actions and whether expanded sampling is required. Expanded sampling programs take approximately two weeks per site and often involve the use of shovels and hand augers.

It is estimated that 20 percent of release sites would need additional site characterization, based on analytical results of the site evaluation (for example, if sensitive potential targets or impact pathways are identified). Advanced studies to determine the extent of contamination typically require three to four weeks of field time, and may involve the use of drill rigs for deep sampling or hydropunches and backhoes for near-surface sampling. Approximately 80 percent of the drilled holes are backfilled immediately, and the remaining borings usually become environmental monitoring wells. The final recommendation of the site evaluation may call for removal of contaminated material or other remediation measures.

If further investigation of the site was necessary, a remedial site evaluation could be required to determine the relative significance of the site in terms of risk to targets. This stage would also identify cost-effective and efficient permanent solutions for important sites. These studies generally address complex situations that require long-term treatments, and are subject to the regulatory timeframes for submitting remedial reports once the process has been initiated and the sites are published in the *Federal Register*.

Site Cleanup

Areas that support relatively high levels of human contact and biologically sensitive areas would have the highest priority for contaminant removal actions. At lower priority sites, alternatives to removal could include in-situ treatments such as fencing the site to secure it and prevent contact by humans or wildlife, or capping the contaminated area with clean soil or gravel.

During removal, contaminated materials would be excavated (generally no deeper than 5 feet) and removed for treatment and disposal, if necessary. Disturbed areas would be backfilled and leveled, and erosion-control measures would be engineered. Removal activities could involve heavy equipment, such as large and small backhoes, front-end loaders, bulldozers, dump trucks, pickups, and all-terrain vehicles. This type of equipment would be transported overland in winter, or a barge could be used if the site was accessible by water. At sites where cleanup could only be accomplished in summer, a gravel pad or road might be constructed for use during the operation to protect the underlying soil and vegetation, and then removed after project completion.

Recreation and Film Permits

The BLM issues special recreation permits to commercial recreation operators, such as hunting and float-trip guides, who focus their activity along the Colville and some larger rivers in the NPR-A, such as the Utukok and Kokolik. Hunting or float trips would consist on average of 10 people, and commonly occur from March through September. Some special recreation permits could also be associated with other types of use, such as filming of natural resources and wildlife. Float-equipped aircraft could be used to take hunters or sightseers to lakes or rivers. These flights could result in camping within the planning area at a level similar to that of fly camps or backpack camps.

Boating parties along the rivers would carry enough fuel for a small stove and their boat engines. They would typically camp for no more than one night in any one place, and their camping practices and impacts would generally be consistent with those of fly camps or backpack camps described earlier in this section under “Ground Activities and Camps.”

In addition, small parties use the rivers for non-commercial recreational hunting and fishing or float trips, and there is a limited amount of backpacking in the NPR-A. The frequency and locations of these activities are not quantified and permits are not required. Nevertheless, such activities will continue under all alternatives. Use of rivers for both permitted and non-permitted float trips would probably increase under Alternatives B and C on those rivers that are recommended for Wild and Scenic River designation.

Pre-development Research and Monitoring for Offshore Development

In addition to ongoing research and monitoring in the NPR-A, the BLM expects environmental studies to be conducted to collect baseline information prior to development of infrastructure within NPR-A or outside its boundaries (e.g., in the Chukchi Sea). Pre-development research and monitoring for development in NPR-A is discussed in section 4.2.1.2. Research and monitoring for development outside NPR-A are summarized briefly here. For example, in 2012 BLM issued permits to Shell Gulf of Mexico Inc. (Shell) to conduct summer studies on surface hydrology, coastal processes, terrestrial and coastal habitat assessments, fish and wildlife surveys, and surveys of cultural resources in NPR-A (USDOI BLM 2012). Access to NPR-A is typically by aircraft, and approximately 1,000 helicopter take offs and landings were expected for the 2012 environmental studies. Field crews (currently 20 to 50 personnel) and helicopters are based at previously established commercial camps at Wainwright, Atqasuk, or Umiat. In the future temporary camps at yet to be determined sites could be established. These types of studies from Shell, as well as other companies or organizations, will likely continue and increase in scope and intensity while large-scale infrastructure projects are in the planning phase.

4.2.1.2 Oil and Gas Exploration and Development Activities

Introduction

This section provides an estimate of the levels of petroleum-related activities and associated surface disturbances for each alternative. It also presents the oil and gas resource estimates in the NPR-A and identifies the assumptions used to determine the type and level of projected oil and gas activity. The estimates and assumptions are preceded by a general description of the activities typically associated with oil and gas operations on the North Slope of Alaska. The petroleum-related activities described in this section are applicable in a general sense because the timing and location of future commercial-sized discoveries cannot be accurately predicted until exploration drilling occurs. However, it is reasonable to expect that new technologies and designs developed in the future will augment exploration and development efforts and will enhance the safety and efficiency of operations while minimizing the effects of oil and gas activity on the environment.

Current state-of-the-art oil and gas technologies, methods, and designs are used to project scenarios for future petroleum development. Petroleum-related activities include such major undertakings as conducting seismic operations; constructing ice roads and snow trails for transporting equipment and supplies for winter drilling of exploration wells; drilling exploration and delineation wells; constructing gravel pads, roads connecting production pads to main facilities, and landing strips; drilling production and service wells; installing pipelines; and constructing oil and gas processing facilities. Impacts caused by the extraction of resources for energy purposes cannot be assessed without estimating future activity. A fundamental assumption of these scenarios is that the level of future activities is directly related to the petroleum resource potential made available for leasing and development. However, industry's interest in exploring for new reserves is influenced by profit motives, where opportunities for new production in northern Alaska must compete with projects elsewhere. Consequently, future development activities and associated impacts are influenced by several factors, including the perceptions of economic potential of the area, the areas available for leasing, industry's ability to identify prospects to drill, and the competitive interest in exploring for new fields.

Description of Typical North Slope Oil and Gas Activities

The following description of oil exploration and development activities reflects common industry practice, particularly in recent years, on Alaska's North Slope. It should be noted, however, that federal, State, and local regulations, including management decisions adopted through this plan, may limit where, when, under what conditions, and even if these activities may be allowed within the NPR-A.

Petroleum Operations in Arctic Conditions

1. Past Experience

Oil and gas operations have been conducted in the North American Arctic for over 90 years. Early exploration drilling in northern Canada resulted in an oil discovery at Norman Wells in 1920, a field that has produced intermittently since then. In 1946, the U.S. Navy discovered the Umiat oil field located in the southeastern portion of the NPR-A. The Navy's exploration program also discovered the South Barrow gas field, which began production in 1950 to supply government facilities and the community of Barrow. Extensive exploration in the NPR-A by the Navy, and later by the U.S. Department of the Interior (U.S. Geological Survey), ended in the early 1980s.

Exploration efforts in the 1960s resulted in numerous oil and gas discoveries in northern Alaska and in Canada's Mackenzie Delta. The largest of these, the Prudhoe Bay field discovered in 1967, has produced about 13 billion barrels of oil. After the completion of the Trans-Alaska Pipeline System in 1977, a number of oil discoveries on State of Alaska lands on the North Slope fed into the Trans-Alaska Pipeline System, reaching a peak production rate of 2.0 million barrels per day in 1988. A leasing program in the NPR-A was initiated by the BLM in the early 1980s and resumed in 1999 after completion of the 1998 Northeast Final IAP/EIS and issuance of a Record of Decision. The 1994 Alpine oil field discovery on State land and near the eastern NPR-A boundary was undoubtedly the most important factor in the renewed interest in leasing in the Reserve. Oil production from the Alpine field began in November 2000 and the field was producing 115,000 barrels of oil per day by late 2004. Combined production from the original Alpine field (pads designated CD-1 and CD-2) and two satellite fields (a drill site pad that flows recovered hydrocarbons to a central facility for processing) brought on line in the middle of the last decade (CD-3 and CD-4) was about 90,000 barrels of oil per day in 2010. Additional discoveries in the northeastern NPR-A, which has resulted in the creation of the Greater Mooses Tooth (164,014 acres) and Bear Tooth (105,475 acres) exploratory units, have also influenced interest in leasing of the NPR-A. Since 2000, industry has drilled 29 exploration wells on 28 federal leases in the Reserve. Fifteen of the 29 industry wells have been in the Greater Mooses Tooth Unit and one in the Bear Tooth Unit. In the course of this exploratory drilling, several geologic play concepts have been tested and some of those have been eliminated from exploration strategies. As a result, 266 of the NPR-A leases have been relinquished and 65 leases have expired, leaving 170 active leases.

Information from decades of experience in Arctic exploration, development, and production is contained in a variety of government and industry reports. No attempt is made here to cite all the historical literature relevant to the NPR-A, but readers are directed to the excellent documentation in Gryc 1988, Schindler 1988, USDOI 1986, ARCO Alaska, Inc. 1996, and National Research Council 2003.

2. Oil and Gas Field Development Timeline

A generalized timeline for a typical project in a remote area of the North Slope is presented in Table 4-2. Discoveries could be announced at any time within a 10-year period (assumed primary lease term) following a lease sale. Delineation and development activities usually take from 3 to 6 years after discovery. Production activities continue year-round for 10 to 50 years, depending on field size. Field abandonment, including well plugging and site restoration, can take from 2 to 5 years after production ends.

Table 4-2. Development timeframe for a typical oil/gas field

Project phase	Duration of activity (years)	Activities
Exploration	1 to 10	• conduct seismic surveys to define prospects • conduct well-site surveys and permitting • drill exploration wells
Discovery	Can occur anytime during or after exploration	• drill additional wells to delineation the extent of the hydrocarbon reservoir • conduct additional seismic survey (3-D) • construct hydrocarbon reservoir models • carry out baseline environmental studies, monitoring, and survey work
Design & permitting	Can occur anytime during or after economic discovery is affirmed and project is sanctioned by lessees	• apply for permits • complete conceptual engineering • complete preliminary engineering • complete detailed engineering • obtain financial approval for project and procure long lead time materials • carry out environmental studies and monitoring
Construction and transportation to site	Can occur any time after authorization for expenditures is approved	• obtain permits to construct • fabricate facilities • install roads and marine facilities to access site • build gravel drilling and production facility pads • transport materials and facilities to site • install piping and facilities • continue to carry out environmental studies and monitoring
Development	Normally takes 3 to 6 years past the initial discovery	• obtain drilling, and operational permits • drill disposal wells • establish construction base camp • begin drilling development wells • install pipelines and pump stations • install production facilities and hookup
Production	10 to 50 years post-development	• continue development-well drilling • ramp-up production (2 to 5 years) • reach peak production plateau (oil: 3 to 5 years; gas: 12 to 13 years) • expect production declines • well workovers (every 3 to 5 years) • conduct infill drilling (well spacing reduced) • employ tertiary recovery methods • progressively shut-in wells • reach an economic limit
Abandonment	Individual wells can take 2 to 5 years	• plug and abandon wells • remove production equipment • dismantle facilities • decommission pipeline • restore and re-vegetate sites • phase out environmental monitoring

This general timeframe suggests that new oil production from leases in the NPR-A is not expected for a minimum of 7 to 8 years following a lease sale. Considering the logistics of oil and gas exploration and development and distances between existing operations and potential future operations in the Reserve, it is more likely that 10 years or more would pass between a lease sale and the startup of oil production from a newly discovered field. Since the 1999 NPR-A leases were issued, several discoveries of oil have been announced but have yet to be developed for production. However, because some of these fields have been discovered and environmental analysis and engineering work undertaken, it is conceivable that development of these already-discovered fields would take place in less than 10 years from the time of the completion of this IAP.

Gas production from NPR-A lease sales would not occur until a transportation system was constructed from the North Slope. Considering the economic and political aspects of future project(s), gas production from the planning area could be delayed several decades.

3. Logistics

The difficult logistics faced by operations on the North Slope typically result in long delays between leasing and production activities. Other than the basic materials (gravel, water, and fuel), nearly all personnel, equipment, and supplies must be transported to the North Slope from elsewhere in Alaska or outside the state. Heavy equipment, such as production modules, is usually fabricated near ports on the West Coast or in Cook Inlet and then transported to the North Slope by marine barge trains (sealifts). Although this mode of transportation is more economical than other means, sealifts are restricted to a short period during the ice-free summer months. The scheduling of fabrication and delivery of modules by sealift is critical.

Two jet airports and a haul road (the Dalton Highway, beginning 84 miles north of Fairbanks) provide service to the oil-field infrastructure surrounding Prudhoe Bay. Although the airports and haul road are generally open year-round, the type of carrier (aircraft or truck) restricts load capacity, and both road and airports are frequently closed during winter storms.

Once materials and supplies are transported to the existing North Slope infrastructure centered at Prudhoe Bay, they must be moved approximately 30 miles from the westernmost road-accessible base camp in the Kuparuk River field to BLM-managed lands in the NPR-A. Overland transportation is relatively open from late December to early May but winter temperatures are extremely cold (sometimes below -40 °F) and "whiteout" conditions are frequent. The sun is down for two months (late November to January). Low-ground-pressure vehicles (Rolligons, tracked Steigers, tracked and runner sleds) can travel at 6 to 8 miles per hour on frozen tundra. Low-ground-pressure vehicles typically transport equipment, crew facilities, and seismic operations. They are also used to transport drilling rigs that can be disassembled into components light enough for transport by these vehicles. (Bruce St. Pierre interview by Jim Ducker, 12/29/06). Ice roads are constructed to move very heavy equipment such as intact drilling rigs and production modules. Heavy equipment typically moves slowly (2 miles per hour) on ice roads or gravel roads.

Remote staging areas are used to support exploration, development, and abandonment activities. A staging area can be established for year-round use and typically consists of facilities housed on gravel pads. Existing pads at Inigok, Camp Lonely, Ikpikpuk, Cape Simpson, Peard Bay, Tunalik, Driftwood, and Brady or on Native corporation lands within the NPR-A could serve this purpose, provided the consistency of their use with specific alternative provisions. These camps would contain storage tanks for fuel, warehouses for supplies, housing for personnel, and permanent gravel airstrips capable of handling large capacity aircraft, such as the Hercules C-130. Staging areas located on the coast also would be designed as receiving terminals for sealifts. Oliktok, to the east of the planning area, has a dock. There are currently no docks in the NPR-A. The Lonely Dew-Line station, however, provides high ground, which can best be accessed by barge at higher tides. Barges can transport heavy equipment and supplies to coastal staging areas during the short summer months (mid-July to late-September), and materials are stockpiled for operations at remote sites during the winter. In winter months, materials and equipment are moved by temporary roads (ice or packed snow) or by aircraft to exploratory drilling sites. Remoteness is a major factor that adds time and cost to operations in the NPR-A, compared to similar activities in the Prudhoe Bay area.

Aircraft, both fixed-wing and helicopter, would provide access for many oil and gas field activities. This could include air support for seismic surveys and exploratory drilling; aerial surveys and support for ground surveys of wildlife, archaeological, and other resources; road and pipeline route surveys; pipeline inspections; and support for other development, operations, and abandonment activities. The location, timing, and frequency of such flights and the type of aircraft used will be influenced by the phase of oil exploration, development, and operations; the location of any oil discovered; the type of development that might occur; as well as restrictions that the BLM and other regulators might place on the lessee or permittee. While a very accurate projection of the number of flights is not possible, the following examples give some indication of the number of flights at different stages of oil and gas exploration and development:

- Commonly at least three summer helicopter surveys for resources (archaeological, lakes, and fish) are required for each exploratory well prior to drilling, and additional trips would be necessary to identify the best access routes and stream crossings.
- Construction-related flights during the development of the Alpine Central Processing Facility and its CD-2 satellite pad ranged from approximately 6 one-way flights a day during winter (nearly all by single or twin engine planes) to approximately 20 round-trip flights daily during the summer (nearly all helicopter or single or twin engine planes).
- In analyzing the impacts of development of five satellite production pads for Alpine, one of which would not be connected by a road, the BLM in 2004 (USDOI BLM 2004b) projected that:
    - "non-operational" helicopter flights for such activities as environmental studies and monitoring and travel for important people and government agency personnel may result in 2,500 summer helicopter flights annually (this would be in addition to an equal number of such non-operational helicopter flights

  associated with the existing Alpine Central Processing Facility and its existing CD-2);
  - during an approximately six-year construction phase, there would be an average of 45 to 70 round-trip operational aircraft flights per month during winter (some months as high as 245 such flights) and 0 to 340 one-way operational flights per month during the summer (some months as high as 615 such flights);
  - during the drilling phase that would occur over the same number of years, there would be approximately 70 to 90 one-way operational flights per month during both summer and winter;
  - once operations began flights would average 8 to as many as 32 flights in winter per month and 8 to as many as 80 flights per month in summer.

- As part of a monitoring report on spectacled eiders at CD-3, a production pad in the Colville Delta not connected to infrastructure by road, the contractor reported on aircraft access to the site during the summer of 2006. (ABR 2007) The contractor reported that helicopters transported crews to CD-3 from May 11 to June 12 and that after July 17 fixed-wing aircraft supported crew shifts, with the exception of occasional use of a helicopter. Statistics on aircraft use were gathered using a camera that snapped 1,440 photos a day from May 31 through July 17, 2006. From June 1 through 19, helicopters (primarily a Bell 212, but occasionally a Bell 206 Jet or Long Rangers) landed (and took off) an average of more than 21 times a day, with the peak day recording 31 trips. (Note: Because of camera maintenance, fog, and the camera's limited view, the flights recorded in the report are considered a minimum.) During that period, fixed-wing aircraft (a CASA and a Twin Otter) averaged 2.4 trips a day. Helicopters were not used between June 20 and July 17, the end of the nesting period for monitored nests. Fixed-wing aircraft use rose to 5.8 flights per day during that period.

Exploration

1. Seismic Surveys

Seismic survey work is an integral part of exploration for oil and gas fields, and requires a permit from the BLM. Reflection seismic data are used to image the layering and geometries of the subsurface and detect changes of lithology and fluid properties. These images when combined with well information can help complete a picture of the subsurface and enhance the ability to successfully identify high-grade drilling targets.

Seismic data has been collected in the NPR-A for decades. Continuing acquisition of seismic data is undertaken for two reasons: (1) to capture higher resolution data through finer seismic grid spacing or grid pattern, and (2) to acquire additional seismic data using advanced techniques over an existing discovery. This is usually used to better image and define the limits of the discovered hydrocarbon pool and to help design efficient development drilling.

2. Seismic Survey Methods

Vibroseis is the standard method for acquiring seismic data on the North Slope, and only occurs in the winter months. The Vibroseis sound source is designed to produce a specific bandwidth of frequencies in a repeatable and consistent fashion. Electronics control a hydraulic system that transmits vibrations through a base plate on the ground. Reflected signals from the subsurface are recorded by arrays of receivers, called geophones, which are installed by hand on the frozen surface of the tundra or frozen waterbodies. Vibroseis trucks are typically run in groups of four or five, with their output signals coordinated to generate the energy necessary to record the seismic records to depths of 20,000 feet or more. Returning signals are gathered from the geophone array and processed to create a coherent representative image of the subsurface. The Vibroseis technique works best on a hard surface, as a spongy surface does not transmit the output energy very well. For this reason, Vibroseis is not an effective tool for summer conditions on the North Slope. Formerly, Vibroseis was not very effective over lakes that were not frozen to the bottom. However, new techniques have recently been successfully tested and implemented to overcome this challenge; geophones are lowered to the floor of the lakes through PVC pipes set through ice. This technique allows the operator to recover the geophones from the bottom of the ice-covered lake and ensures good coupling with the subsurface.

Collection of seismic reflection data in aquatic areas (ocean, lakes, bays, and lagoons) is commonly accomplished using vessels of varying size during ice-free periods. Typically, one or more airguns are used as a sound source. Airguns, which are deployed behind the seismic vessel, generate a seismic signal by creating a sharp air bubble pulse in the water at intervals about once every 10 seconds. Marine receivers are composed of piezoelectric hydrophones that are contained in long, sealed tubes. Receiver systems can be deployed either as “streamers” that are towed behind a vessel or as “cables” that are laid directly on the seabed or lake bottom. Seismic streamers can be several miles in length and are generally used in deeper water where maneuverability is not an issue. Seismic cables (on-bottom cables) or “nodal” cableless systems are used in shallower water or in waterbodies where ice has not reached the bottom. Both receiver systems contain numerous hydrophones that measure faint pressure signals returning from reflections in the subsurface. These seismic data acquisition techniques are generally intended for imaging subsurface depths of several hundred feet to 6 miles. Surveys designed for shallower subsurface depths and higher resolution generally employ lower sound levels and shorter hydrophone systems.

Alternatively, seismic surveys have been conducted over frozen lakes using dynamite as the sound source. Shot holes approximately 3 inches in diameter were drilled through the ice and several feet into the lake bottom. Dynamite (or other explosive) charges were installed in boreholes, and geophone receivers were placed on the ice surface. The dynamite charges were then detonated, and reflected energies were recorded by the geophones. Over-ice seismic surveys were conducted in this fashion on Teshekpuk Lake in 1974 and 1975. The approximately 120 line-miles of seismic data that were collected during these surveys are the only seismic data available for large portions of Teshekpuk Lake. Dynamite source seismic offers a broader frequency spectrum at a lower cost but can only be used for two-dimensional surveys and generally is dismissed because of its environmental impacts. In 1991, Alaska Department of Fish and Game imposed blasting standards that limit the power of explosives used near fish bearing waterbodies, effectively prohibiting the use of dynamite directly within the waterbodies.

3. Seismic Survey Types

Reflection seismic surveys, simply called seismic, image the subsurface in two or three dimensions (2-D and 3-D seismic). 2-D seismic involve widely spaced survey lines and are useful for broad reconnaissance survey work and provide a cost effective method for initial data collection. 3-D seismic requires a dense grid of seismic lines to provide a more detailed image of the subsurface under the survey area, improving the geological and geophysical picture of the subsurface. 3-D seismic is often collected prior to drilling an exploration well in the NPR-A.

Similar acquisition and recording equipment are used for both survey types. Setting up 3-D acquisition equipment is more efficient because the equipment does not have to be moved far between new survey lines. 3-D seismic comes at a greater cost than 2-D because of the amount of data collected, the larger crew sizes, equipment inventories, and the additional processing required. Advances in acquisition techniques and technologies have made 3-D seismic more cost effective option for regional reconnaissance. 3-D data improve exploration success rate and aid in placing productive wells at optimal locations. Analysis of 3-D amplitude attributes can be a robust lithologic discriminator identifying potential reservoir sands from shales. This is critical information when used to image stratigraphic style traps.

Several advanced seismic techniques can be used to image producing fields. Lands already in production are sometimes subjected to additional 3-D seismic to monitor changing reservoir properties resulting from production. This seismic technique is sometimes called 4-D seismic because, though it would be conducted like 3-D, repetition adds the dimension of time. This technique can also utilize permanent static geophones to ensure repeatability and coupling. Multicomponent seismic acquisition uses specially designed geophones to record the shear component of seismic reflections. Recorded shear wave data, when combined with well and primary wave data, can be used to characterize lithologic properties over an existing production area.

Three to four seismic crews can be active on the North Slope each winter; one to two crews have collected seismic data during some winters in NPR-A. On-shore seismic surveys on the North Slope are only collected in the winter when sufficient snow cover and ground frost is present to minimize any damage to the tundra surface. These surveys employ low ground pressure vehicles (soft tracks) to further minimize potential impacts. While the winter operating period can be as long as 5½ months (early December to mid-May), typical seismic operations for an individual survey lasts about 100 days.

Mobile camps called "cat trains" support seismic operations and could be staged from locations based on proximity to existing facilities. Seismic work performed near the Greater Mooses Tooth Unit (GMT) could be staged from Alpine Field, for example. Each cat train would consist of 10 (2-D surveys) to 20 (3-D surveys) vehicles, one or more fuel trucks and modular camp units comprising two or three strings of trailers. Each string would have four to eight trailers and would be pulled by a single bulldozer or low-ground-pressure vehicle. Bulldozers, equipped with wide snow tracks, and modular units generally exert greater ground pressure than do the vehicles that run the seismic lines. Seismic survey equipment has been stored at the Inigok airstrip in the eastern NPR-A and used in subsequent winter seismic programs. This location, Umiat, and similar locations farther west and south are preferable to the Kuparuk oil field because they put the seismic trains much closer to the area of exploration interest.

The techniques of setting up geophone arrays and shot points are similar for 2-D and 3-D surveys. However, 3-D surveys are more efficient because the equipment does not have to move far between lines, and 3-D surveys generally provide better coverage of subsurface features. The exterior dimensions of 3-D survey blocks could range to tens of miles on a side. The number of line-miles crossed in a 3-D survey area would be much greater than for 2-D surveys because the survey lines would be closer together. They are more expensive than 2-D surveys, and are not used for initial reconnaissance mapping unless it is essential to map subtle stratigraphic prospects. New “nodal” technology recently developed may reduce impacts typically associated with current seismic acquisition methods by replacing geophone cables with wireless autonomous geophones. These nodal” geophones can be deployed and sustained up to 12 days on battery power thus eliminating support and deployment equipment associated with cable arrayed seismic.

A 2-D survey area varies in size. For this analysis, it is assumed that 500 line-miles would be collected in a 900 square mile area. The individual survey lines would be several miles apart and the surveys would tie between existing wells and as infill to existing surveys. About 10 vehicles, including Vibroseis (sound source) vehicles and receiving vehicles (geophone support and recording equipment), would run each line of 2-D seismic. Approximately 50 to 70 personnel would be required for each survey group including all support personnel associated with the winter camp. The vehicles would run parallel to each other through an area about 200 feet wide and the survey party would collect 5 to 10 line-miles of seismic data per day. The maximum area covered by seismic vehicles would be approximately 12,121 acres (500 miles long by 200 feet wide), although not all of the area within the 200-foot-wide path would be traversed by vehicles.

Recent experience shows a large 3-D seismic operation can survey an area of about 900 square miles in a single winter season. An operation like this typically involves about 12 to 14 tracked vibroseis vehicles supported by 6- to 8-tracked cable trucks. Each line-mile would consist of a pair of linear areas, each about 100-feet wide, through which the vehicles would drive. The receiver lines would be spaced about 660 to 1,320 feet apart, while the source line upon which the survey units and vibrator travel would be spaced about 660 to 1,760 feet apart and typically cross diagonally or orthogonally to the receiver lines, depending on the acquisition parameters of the survey. Vehicle travel would be restricted within the grid area. In general, all vehicles would travel within 50 feet of receiver lines. For any given receiver line, a path of about 100 feet could be impacted by vehicle use (50 feet on either side of the line). The area impacted along the source line would be less than 50 feet wide. Depending on survey acquisition parameters, anywhere from 10 and 30 percent of the 3-D survey area would be impacted along the source and receiver lines. This estimate is considered high, since some areas impacted would be common to both the source and receiver lines.

Once in the area of operation, camps typically are moved every few days to once a week. Field camp is generally comprised of six camp strings of five ski-mounted trailers. Activities that are in remote locations would be supplied by air transportation to gravel or ice airstrips or brought in on Rolligon or tracked Steigers and tracked trailers. The fuel truck(s) or fuel sled(s) make runs back to a fuel-supply depot, such as the Inigok airfield, through the course of the seismic operation. These fuel runs may occur daily or every few days depending on a variety of factors, including the size of the operation and weather conditions. Data collection operations are conducted by all-terrain, low ground-pressure vehicles (both wheel and articulated-track designs). Camp supplies (food, fuel) are transported to the survey area by both ground vehicles and fixed-wing aircraft.

In the mid-1990s, seismic equipment had been stored in staging areas on existing gravel pads during the summer. A repair crew would spend 2 to 4 weeks performing annual maintenance and installing upgrades to seismic equipment. Remote staging expenses include facilities, security, flight logistics, and resupply of parts, all requiring weekly fixed-wing and helicopter flights. The expenses of summer maintenance programs are likely to make this activity cost prohibited in the future. Upon completion of the work, all wastes would be removed and disposed of at approved disposal sites on the North Slope. Disposal of solid wastes would take place in accordance with applicable rules and regulations; none of these activities would require the establishment of new landfill locations. No solid waste would be disposed of on site.

4. Seismic Surveys and Evolving Views on Resource Potential

Figure 4—1 on page 17 shows seismic activity for the past two decades. From 1990 until 2010, 32 seismic permits comprising 10 2-D and 22 3-D surveys were issued within the entire NPR-A. Most of these seismic surveys were triggered by the mid-1990s Jurassic aged Alpine discovery just east of the NPR-A. The USGS and the oil industry, based on extant 2-D seismic data and on well information, believed that the Alpine and other Beaufortian sequence plays may extend across the NPR-A from the Alpine Field to Barrow. In 2002, the USGS estimated over 5 billion barrels of undiscovered technically recoverable oil within the Beaufortian upper Jurassic topset play (Alpine play) in the Northeast NPR-A planning area alone. Only one 3-D seismic survey was acquired outside of this Beaufortian sequence prospect area.

According to the 2010 U.S. Geological Survey NPR-A resource assessment, "recent exploration drilling revealed an abrupt transition from oil to gas and reduced reservoir quality in the Alpine sandstone 15 to 20 miles west of the giant Alpine oil field." Seismic and well data indicate that potential Beaufortian sequence reservoirs do not extend from the Alpine field across the northern quarter of NPR-A to Barrow but were rather localized in the northeast corner of the NPR-A, and much of the oil was trapped in relatively small 700-acre pools. Poor reservoir quality and high gas to oil ratios further downgraded the prospectivity of the Beaufortian sequence within the NPR-A. Overall, the last decade of drilling discovered more gas and lesser quality reservoir resulting from a combination of deeper burial, higher heat flow and poor reservoir composition.

Seismic activity averaged around two seismic surveys per year from the 21 years extending from 1990 to 2011. This number should not be seen as a most likely average for the next 10 to 20 years. As of recent, there have been no significant discoveries or emerging trends that would encourage similar seismic activity. The proximal area to the Barrow Arch—considered to be most prospective for trapping subsurface oil—has been nearly completely imaged with 3-D seismic. New seismic acquisition within the NPR-A has not occurred since 2007, except for a small portion of a resurvey of the Alpine field. The last permit issued in 2010 was a reshoot over the Colville River Unit and areas west of the Alpine Field, over or near to existing production.

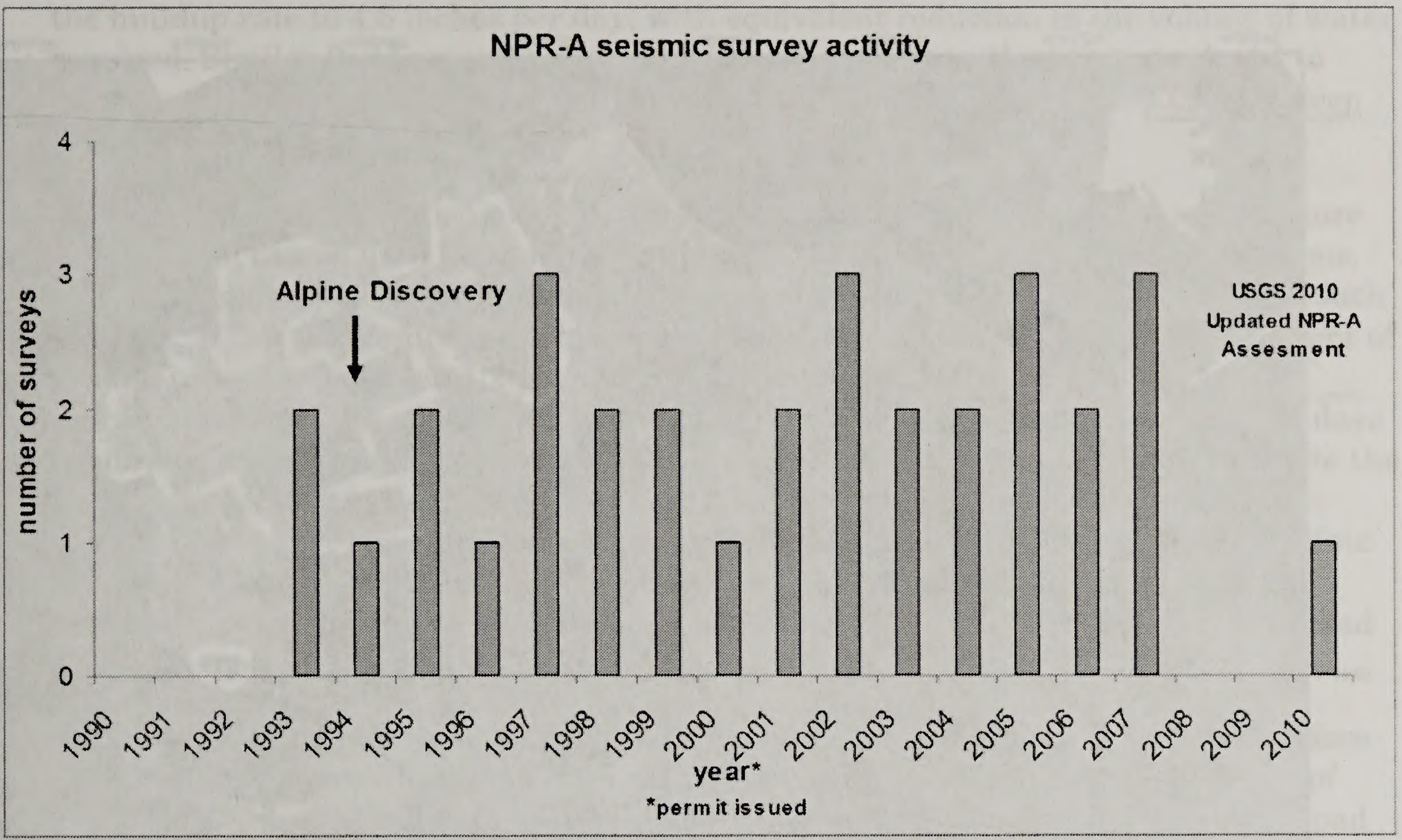
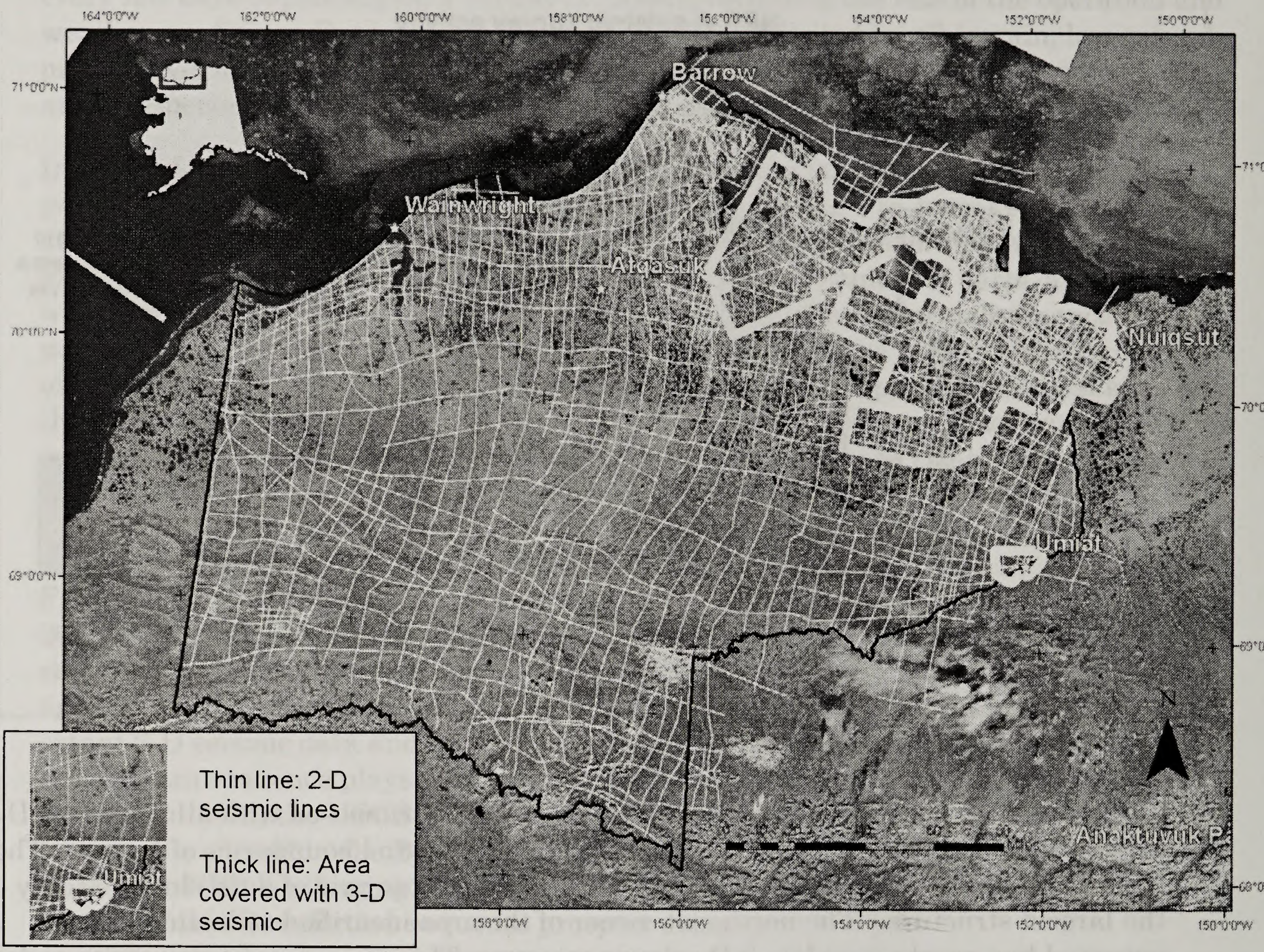


Figure 4—1. NPR-A seismic survey activity

Figure 4—2 on page 18 shows a map of the NPR-A superimposed with all 2-D and 3-D seismic surveys, well locations, potential gas prospects, and boundaries of interest. The Husky-USGS 2-D grid covers the entire NPR-A. This loose grid of data identifies only the largest structures. The northeast corner of the area identified as having high oil potential has nearly complete 3-D seismic coverage. This area contains two units and has most of the oil discoveries. It is unlikely new exploration-focused surveys will be acquired in this area; however, development in the Greater Mooses Tooth and Bear Tooth units could lead to updated seismic acquisition. The medium oil potential area has about 65 percent 3-D coverage making future exploration focused seismic acquisition possible if a new play or fairway is established.

South and west of the oil and condensate potential area are large, mostly untested, gas prone structures. These structures consist of relatively shallow Nanushuk Formation folds and Fortress Mt. Formation fault bounded structures and thrusted duplexes. Only 1 percent of this area has been covered with 3-D seismic. This remote area has seen little industry interest in the last 30 years or more. Sparse well control and relatively poor quality seismic make any assessment of its hydrocarbon uncertain; the few wells in this area date from the 1940s-1950s, making meaningful log analysis difficult. Only two out of the eight tested structures discovered significant oil and or gas accumulations. Exploration 3-D seismic data over such large, gas-prone structures may draw industry interest in the future if a gas pipeline is constructed from the North Slope or new discoveries are made associated with the Umiat Field development.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Thin line: 2-D seismic lines
Thick line: Area covered with 3-D seismic

Figure 4—2. Map showing NPR-A seismic surveys

5. Ice Roads, Snow Trails, Ice Airstrips, and Ice Drilling Pads

Exploratory drilling typically occurs during the winter when conditions facilitate tundra travel and ice road, snow trails, ice airstrips, and ice pad construction. Ice roads and snow trails would provide seasonal routes for heavy equipment, supplies, and personnel accommodations moved to remote ice-pad staging areas or well locations and are necessary for moving most current North Slope drill rigs. Ice airstrips are used for winter aircraft access to remote locations.

Construction of ice roads begins by compacting snow with wheeled front-end loaders and water trucks. If prepacking is authorized, it is done with low-ground-pressure vehicles or various tracked rigs. Typically, ice roads are designed to be a minimum of 6 inches thick and 25 to 35 feet wide, and can be tens of miles long. An ice-road construction crew can build about one mile of road per day and use approximately one million gallons of water per mile of road (ConocoPhillips Alaska, Inc. Plan of Exploration – Cassin exploration sites, 2006). Water supplies must be located along the proposed route. New ice-road construction methods, such as using aggregate chips shaved from frozen lakes, substantially decrease both water demands and construction time. For example, under good (very cold) conditions, an ice-road-buildup rate using only liquid water is 1.5 inches per day, whereas using aggregate chips could increase the buildup rate to 4.5 inches per day, with equivalent reduction in the volume of water required. Similar flooding and composite (aggregate chip) methods are employed to construct ice bridges over rivers and lakes. Floating ice bridges are used to cross deep rivers, such as the Colville River.

Snow-packed trails are also constructed and approved for use by low-ground-pressure vehicles and can be used for moving equipment, supplies, personnel accommodations, and drill rigs capable of disassembly to components small enough for transport on such vehicles. When the tundra is open for prepacking, two vehicles with the least amount of ground pressure (between 1.2 psi and 2.0 psi) are run side-by-side and follow GPS coordinates along the entire length of the approved snow trail route. After several days of snow capture along the new trail, these vehicles drive the route again to complete the snow compaction process and open the trail for use by other low-ground-pressure vehicles that exert less than 4 psi of pressure to the ground. Due to winter-travel time constraints, costs, and extended distances from current infrastructure to new exploration areas in the NPR-A, frequency in the construction and use of snow-packed trails is expected to increase.

Ice pads and ice airstrips are constructed much like ice roads, with the tundra surface flooded with water to build up progressive layers of ice. As with ice roads, the use of aggregate chips speeds the process while decreasing water demands. A typical ice pad requires about 10 days to construct and is designed to be 1 to 2 feet thick (possibly more depending on topography), cover 6 acres (500 feet by 500 feet), and require approximately 5,000,000 gallons of water to construct (500,000 gallons per day) (ConocoPhillips Alaska, Inc. Plan of Exploration – Cassin exploration sites, 2006). Depending on the well site, ice pads could range in size from 3 to 10 acres, while ice airstrips are approximately 10 or 11 acres. Generally, exploration sites that are further from support infrastructure require larger ice pads to store equipment and supplies. Water requirements vary, depending on the pad size and availability of aggregate chips shaved from nearby lakes. Seasonal maintenance of ice pads and roads requires approximately 20 percent of the initial volume of water required to construct the road or pad. Some pads have been maintained over the summer, thereby decreasing the time to mobilize rigs for exploration drilling the following winter.

6. Exploration and Delineation Wells

Although ample exploration drill rigs have been available on the North Slope in recent years, since the resumption of leasing in the NPR-A in 1999, no more than two drill rigs have been active simultaneously in the Reserve in any given season. All exploration has occurred from seasonal ice pads and exploration has averaged three wells per year. Except in rare cases, drilling has been conducted entirely during the winter months (January to mid-April). Exploratory drilling could be conducted in the summer from the very few existing gravel pads in the NPR-A, most likely at Umiat. No new gravel pads are anticipated to be constructed for exploration. (They would be prohibited under all of the action alternatives.) Upon completion of drilling operations, all equipment and materials would be removed over ice roads or snow trails to staging areas and then to other locations on the North Slope. If an exploratory drilling program were to lead to a new field discovery, delineation of the field could take place over subsequent drilling seasons.

Exploration operations require movement of heavy equipment (drilling rigs, drill pipe, and camps) and large amounts of materials (steel casing, drilling mud, cement, and fuel) to remote locations. Approved low-ground pressure vehicles would be used to transport, lighter equipment and personnel via snow-packed trails to construct ice pads, roads, and airstrips. Transportation logistics must also allow for regular crew changes and resupply. An exploration well crew could consist of 30 to 60 people, working 1- to 2-week shifts. The crew would be transported to the site by aircraft landing on constructed ice airstrips. Large lakes (at least 1 mile in length) could be prepared quickly as winter landing strips.

Industry adopts alternative exploration techniques in areas where traditional methods would be limited or challenging because of distance, water availability, or terrain. For example, Phillips Alaska, Inc. used an insulated ice pad west of Teshekpuk Lake to store a drilling rig throughout the summer of 2003, thus enabling a longer drilling period that spring and to more quickly move to a new ice pad to drill the following winter. Anadarko field-tested a new drilling system, the Arctic Platform, which is like an offshore platform for use on land. A self-contained drilling system and crew quarters sit atop a deck made of interlocking modules that rest on pilings set into the permafrost below the tundra. The platform is elevated approximately 12 feet off the tundra, eliminating the need for gravel or ice pads. Surface use of this technology could allow operators to perform exploration drilling outside the winter season, since ice pads would not be required. This technology could also allow access to remote areas, to areas where water to build ice roads is scarce, and to areas where steep grades make it difficult to set a rig. The Arctic Platform concept may have promise for exploration drilling and as a production unit. At this time, however, it is still in the experimental or developmental stage and, consequently, for the purposes of this analysis, it is assumed that this drilling system will not be used.

Exploration wells in the northern portion of the NPR-A (the area of highest oil potential) are likely to range from 7,000 to 8,500 feet in depth. For these depths, most exploration wells could be drilled, logged, and tested within a single winter season. Drilling would take substantially less time near Umiat, where oil accumulations are known to occur approximately 1,500 feet from the surface. Exploration and delineation wells normally are drilled straight down, though directional drilling techniques have allowed an offset of about 1,500 feet for one NPR-A delineation well.

To define the limits of reservoirs after a discovery is made, several delineation/confirmation wells would likely be drilled before making a commitment to full project development. Additional delineation wells surrounding the discovery well would likely be planned for the following winter or two, and would require new ice pads. Of the 29 exploration and delineation wells drilled in northeastern NPR-A since the initial 1999 lease sale, there have been six inferred and announced oil/gas discoveries (Figure 4—11 on page 52). This is an average of about five wells per discovery. Five of the six discoveries are located in the Greater Mooses Tooth Unit, which required 15 exploration/delineation wells. This is an average of about three wells per discovery. Because of high development project costs, two to four successful delineation wells would likely be drilled to establish reservoir continuity over an area. For example, a possible field-development project consisting of two production well pads might require six wells (two exploration and four delineation wells). Delineation-well drilling would be coordinated with any existing 3-D seismic surveys.

After a well has been drilled, it may be tested for the presence of hydrocarbons. The well can be tested using drill-stem testing equipment, where samples are collected in the wellbore, or by flowing fluids to the surface and through a production separator to measure the amount of fluid and the respective fractions of oil, gas, condensate, and water. Most exploration/delineation wells drilled in the last dozen years in the NPR-A have been plugged and abandoned during the same season in which they were drilled because it is more cost-efficient to complete activities in a single season. Cement plugs would be placed throughout the abandoned well bore to prevent migration of fluids and gases and to protect subsurface resources. The remaining recent wells that have encountered potentially producing petroleum have been suspended and shut in with downhold plugs and wellhead gauges to monitor the well. These successful wells could be re-entered for use as production wells at a later time by drilling out the cement plugs. If commercially producible hydrocarbons are found, equipment and materials could be left at the site, supported on pilings, to reduce mobilization time the following winter drilling season. Rock cuttings from exploration and delineation wells could be backhauled to existing disposal wells. It has been proposed that cuttings can be ground, processed, and treated for subsurface disposal in existing abandoned wells, but this technique has not yet been used in NPR-A. The BLM has not allowed surface use of muds and cuttings; see required operating procedures/best management practices A-2 in Table 2–3 in Chapter 2, Volume 1. Upon completion of drilling operations, all equipment and materials would be moved back to staging areas on ice roads or snow trails. No materials or drilling wastes (solid mud and cuttings) would remain at the site.

7. Water Demand and Rock Cuttings

Drilling operations require large amounts of water to create drilling fluid. Drilling fluid is typically a preparation of water, clay, and chemicals that is circulated into a wellbore during drilling. The drilling fluid is used to lubricate and cool the bit, transport rock cuttings to the surface, prevent sloughing from the sides of the drill hole, and provide a weighting medium to prevent the migration of oil and other fluids into the well. A 10,000-foot well could require approximately 420,000 to 1.9 million gallons of water for drilling, in addition to approximately 100 gallons per day for each person in the drilling crew (for camp use). Approximately 30 to 60 people would be needed to operate a drilling rig and infrastructure operations. Over a 3- to 4-month drilling season, drilling a single exploration or delineation well could require a total of 1,650,000 gallons of water, which would be obtained (if possible) from a source close to the well site. The use of melted snow could supplement this water requirement.

A 10,000-foot well could use 630 tons of drilling mud and produce 820 tons of rock cuttings. Until oil and gas production facilities are developed in NPR-A, all cuttings and solid drilling mud would have to be hauled to existing facilities in the Prudhoe-Kuparuk areas. The cuttings that meet Alaska Department of Environmental Conservation's reuse criteria may be used as landfill cover, road and pad maintenance, or other similar uses outside of the NPR-A (required operating procedure/best management practice A-2 prohibits such use in the NPR-A).

8. Shortened Winter Season

The length of the winter season is a main concern for oil and gas activities. Data from the past 25 years shows that it varies from 103 to as long as 194 days. The average winter season is about 145 days (unpublished AK DNR 2010). Data for the last 10 years where industry activity has taken place in the northern NPR-A is about 134 days of tundra travel. To date no seismic surveys have been compromised by the length of the winter season and the exploration season has been sufficient for exploration well drilling. However, some wells have encountered delays from completion problems and some testing and coring activities have been curtailed because of concerns of ending activities and removing rigs and materials from the tundra before breakup.

Industry adjusts to the variable winter season through logistic strategies and technological innovation. Existing gravel pads and airstrips such as those at Inigok and E. Simpson Husky well sites have been used for over summer storage to facilitate efficient use of the limited winter season. NPR-A exploration has seen greater use of low-ground-pressure vehicles, packed snow roads, prepack of ice roads, and of drilling rigs that can be disassembled into components light enough to be transported across compacted snow trails or flown to locations. Anadarko's Arctic Platform described earlier also was designed in part to counter the limitations caused by the shorter drilling season.

Discovery and Development

1. Overview

Preproduction development activities, including field delineation, for any particular discovery could take four or more years prior to production startup. In the case of the initial discoveries following the 1999 lease sale in the northeastern NPR-A, more than a decade has elapse without production and there is reason to believe that production from most existing leases and leases sold following this IAP may also take a decade to be realized. Experience on State lands to the east of the NPR-A suggests that where considerable infrastructure already exists, future satellite prospects may be developed within about 10 years of lease sales. Production activities would likely last between 10 and 50 years, depending on the size of the field. Abandonment activities, including well plugging and site restoration, could last 2 to 5 years after the end of production. The discovery and development of commercial fields is likely to occur gradually across the NPR-A as oil and gas companies respond to changing market conditions and changing opportunities presented by developments elsewhere on the North Slope, such as potential development in the Chukchi and Beaufort seas and development of infrastructure to the east of the Reserve. As a result, petroleum activities on lease tracts could continue for decades after a lease has been sold.

After a commercial discovery of oil or gas has been confirmed by delineation wells and seismic surveys, a number of construction activities are required to develop a permanent production operation. A production operation complex would, at a minimum contain a production pad that could potentially support dozens of wells and contain a large central processing facility for an oil field or a combined central processing/gas compressor facility for a gas field. In addition, a production complex would include an airstrip, camp facilities, and storage yard. The production operation also would include feeder lines, regional pipelines, booster pump (oil) or additional compression stations (gas), a high-pressure gas trunk line, a gas conditioning facility, and an oil-sale and/or gas-sale pipeline to transport the resource to market. Depending on the size of the field or the presence of nearby fields, the production operation complex may also include an outlying oil production pad or one or more gas production pads. The smaller satellite would serve primarily as a well pad designed to produce hydrocarbons from a smaller prospect located beyond the reach of wells drilled from the main production pad/central processing facility. A gathering system to the central processing facility or central processing/gas compressor facility, and a road (or in some cases an airstrip instead of a road) would be needed to access the satellite pad. While some developments, such as two proposed for GMT-1 and GMT-2, could connect by gravel road to the existing Alpine central processing facility, we anticipate that development in the NPR-A would generally not connect by road to areas outside of the NPR-A. A borrow site from which to acquire gravel for pads, roads, and an airstrip may be a part of each production operation, but depending on the availability of gravel and the proximity of production operations, some borrow sites may provide gravel for multiple production operations.

The U.S. Geological Survey's (USGS) 2010 assessment of potential conventional oil and gas resources in the NPR-A substantially reduced the projections of technically recoverable oil and more moderately reduced the projections of technically recoverable gas compared to the agency's 2002 assessment. The USGS's reduction in its estimate of technically recoverable oil resulted in the agency also reducing its projections of the scale of economically viable oil developments. The USGS estimates that there are 16 undiscovered oil accumulations with a technically recoverable mean total estimate of 896 million barrels of oil. Eighty-seven percent of the estimated technically recoverable oil is in accumulations smaller than 256 million barrels of oil. Assessed oil accumulation sizes are small by North Slope standards, with the average size for the technically recoverable mean estimate at 56 million barrels of oil. The USGS considers such small oil accumulations economically producible if they are in proximity to each other but these small accumulations would need smaller infrastructure compared to other North Slope production facilities.

The agency posits two types of oil development strategies. The larger would be a joint oil field development. It would have two production pads, with one pad also housing a central processing facility. The USGS considers joint oil field development viable only in those parts of the NPR-A it designates as economic zones 110 and 120 (see the sidebar for a discussion of economic zones and Figure 4—3 on page 24 for their locations). In these two zones, oil accumulations are anticipated to be clustered so that facilities can be shared (Attanasi and Freeman 2011). The remaining economic zones are assumed to have too few expected oil accumulations in proximity to one another to justify joint development. However, in the process of gas exploration within the NPR-A, assessed oil accumulations located beyond economic zones 110 and 120 are expected to be found, and some will be commercially developed as stand-alone one-production pad/ central processing facility oil fields.

The USGS estimates that there are 70 undiscovered non-associated gas accumulations at the mean estimate of 52.8 trillion cubic feet of gas, with 17 percent of the gas (8.74 trillion cubic feet) assessed in undiscovered accumulations containing at least 3 trillion cubic feet (500 million barrels of oil equivalent.) Although the sizes of undiscovered nonassociated gas accumulations are modest, the number of USGS-assessed gas accumulations in size classes from 250 billion cubic feet to 768 billion cubic feet will provide opportunities for joint development. This is due to the comparatively large volume of gas in such accumulations and the large numbers of accumulations (i.e., 52 gas accumulations at the mean technically recoverable USGS estimate; see Table 2 of Attanasi and Freeman 2011). Joint gas development would extract the resources of two gas accumulations with a shared central processing/gas compression facility, while a stand-alone gas field would develop gas from a single accumulation with a central processing/gas compression facility. A joint oil development complex and a stand-alone oil facility both require a central processing facility and associated support facilities. For analysis in this plan, the North Slope Nikaitchuq oil discovery represents a reasonable analog from which a hypothetical joint oil development complex or a hypothetical stand-alone oil facility can be conceptualized. The Nikaitchuq has a 200 million barrel recoverable reserves estimate and a peak production of 28,000 barrels per day from two production pads (22 wells onshore and 30 offshore).

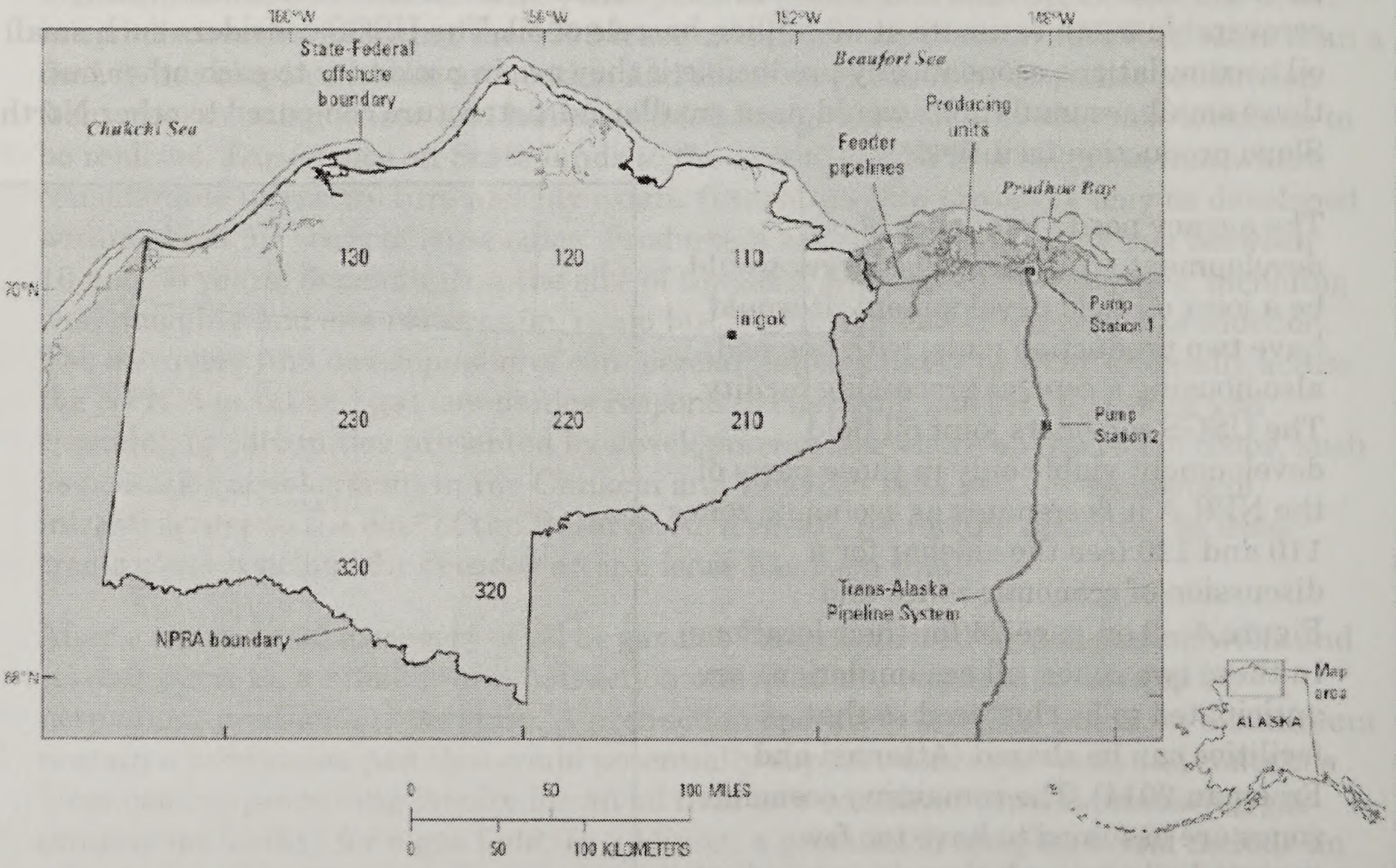
160°W
156°W
152°W
148°W
State-Federal offshore boundary
Beaufort Sea
Chukchi Sea
Producing units
Feeder pipelines
Prudhoe Bay
130
120
110
70°N
Inigok
Pump Station 1
230
220
210
Pump Station 2
330
320
Trans-Alaska Pipeline System
NPRA boundary
68°N
Map area
ALASKA
0 50 100 MILES
0 50 100 KILOMETERS

Figure 4—3. USGS's eight economic zones of the NPR-A

Figure 4—4 shows the major surface features for a hypothetical joint oil development complex located in economic zones 110 and 120 and comprising two oil accumulations. The joint complex includes one combined central processing facility/production pad producing one accumulation and another satellite production pad producing the second accumulation. In addition, the joint oil facility would have a feeder pipeline from the satellite field to the central processing facility, a feeder pipeline from the central processing facility to a hypothetical economic zone oil hub, and a gravel airstrip. Each economic zone hub gathers the oil or gas produced from the respective fields within the zone and increases pipeline pressure for more efficient transport of the product to and through a larger diameter regional pipeline. Table 4-3 on page 26 describes the attributes of these facilities.

Figure 4—5 on page 27 shows the major surface features for a hypothetical stand-alone oil development facility that could be located in any of the economic zones and comprising a single oil accumulation. The stand-alone development includes one combined central processing facility/production pad producing the lone accumulation, a feeder pipeline from the central processing facility to the economic zone oil hub, and a gravel airstrip. Table 4-4 on page 28 describes the attributes of this facility.

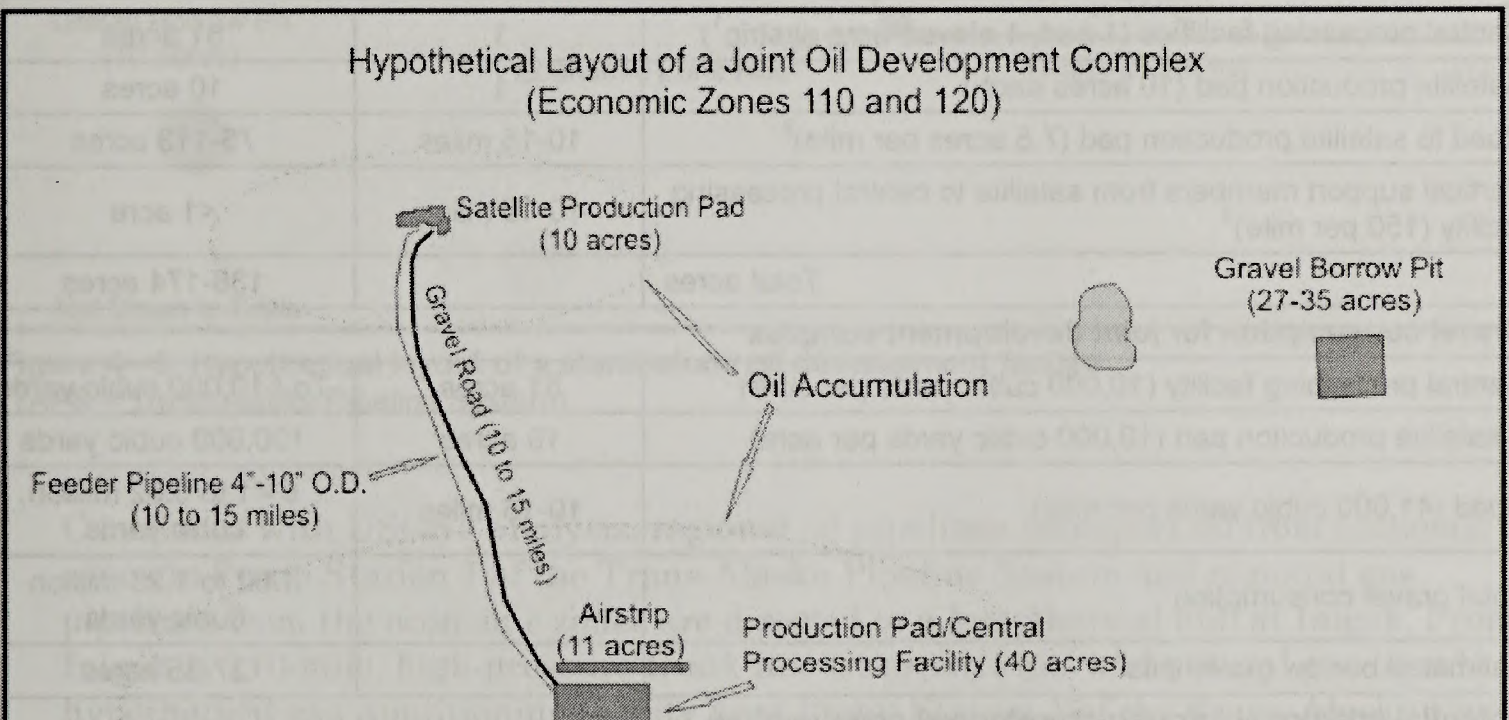
Hypothetical Layout of a Joint Oil Development Complex
(Economic Zones 110 and 120)
Satellite Production Pad
(10 acres)
Gravel Borrow Pit
(27-35 acres)
Gravel Road (10 to 15 miles)
Oil Accumulation
Feeder Pipeline 4"-10" O.D.
(10 to 15 miles)
Airstrip
(11 acres)
Production Pad/Central
Processing Facility (40 acres)
Feeder Line (4"-10" O.D.) to
Economic Zone Hub
(10 to 15 miles)
Regional Line (12"-16" O.D.)
to TAPS
Economic Zone Hub
(90 to 170 miles)
Not Drawn to Scale

Figure 4—4. Hypothetical layout of a joint oil development complex

The hypothetical transportation system under this IAP/EIS moves oil from the NPR-A to the Trans-Alaska Pipeline System and nonassociated gas to a proposed natural gas conditioning plant located near Pump Station 1 of the Trans-Alaska Pipeline System. These systems consist of in-field feeder (gathering) lines, feeder lines from the fields to economic zone hubs, regional pipelines, and for gas, a high-pressure trunk line. The systems also include additional bundling of utility lines and water lines (for waterflood of oil discoveries) to the respective operating field. These lines may use the same vertical support members and rights-of-way as the pipeline transporting produced oil and gas to the regional pipeline. Booster pumps for oil or compression stations for gas are added to the respective pipelines at intervals of 120 miles from the source to keep the fluids (oil, gas, and water) in motion or to keep the nonassociated natural gas pressurized.

Table 4-3. Estimated area of surface disturbance and amount of gravel needed for a hypothetical joint oil development complex located within economic zones 110 and 120

Facility/disturbance	Number of facilities/miles/ acres	Total amount of impact
Joint development complex of 1 central processing facility/production pad and 1 satellite production pad with connecting road		
Central processing facilities (1 pad, 1 eleven-acre airstrip[1])	1	51 acres
Satellite production pad (10 acres each)	1	10 acres
Road to satellite production pad (7.5 acres per mile)[2]	10-15 miles	75-113 acres
Vertical support members from satellite to central processing facility (150 per mile)[3]	10-15 miles	<1 acre
Total acres		136-174 acres
Gravel consumption for joint development complex		
Central processing facility (10,000 cubic yards per acre)	51 acres	To 510,000 cubic yards
1 satellite production pad (10,000 cubic yards per acre)	10 acres	100,000 cubic yards
Road (41,000 cubic yards per mile)	10-15 miles	0.41 to 0.62 million cubic yards
Total gravel consumption		1.02 to 1.23 million cubic yards
Estimated borrow gravel pits[4]	1	27-35 acres
Potential additional infrastructure/gravel consumption		
Staging area (50 acres)[5]	1	500,000 cubic yards

1. An airstrip would comprise about 11 acres of a central processing facility's total. It could be part of the road system like at Alpine CD-1.
2. Assumes that there are 10 to 15 miles between each satellite production pad as road distance may vary to avoid lakes, other impediments, or to comply with permitting requirements.
3. The number and distance between vertical support members varies as their use (http://www.alyeska-pipe.com/PipelineFacts/pipelineengineering.html)
   Distance between:
   - Anchor supports — 800 ft. to 1,800 ft.
   - Standard supports — 60 ft. approx.
4. Assumes one acre disturbed for a gravel pit to meet the gravel needs for five acres of gravel pad, road, airstrip, or other development.
5. If a new development is too far from an existing gravel pad, it may be necessary to build a staging pad. This would add 50 acres to the gravel footprint and 10 acres to the area disturbed by gravel pits.

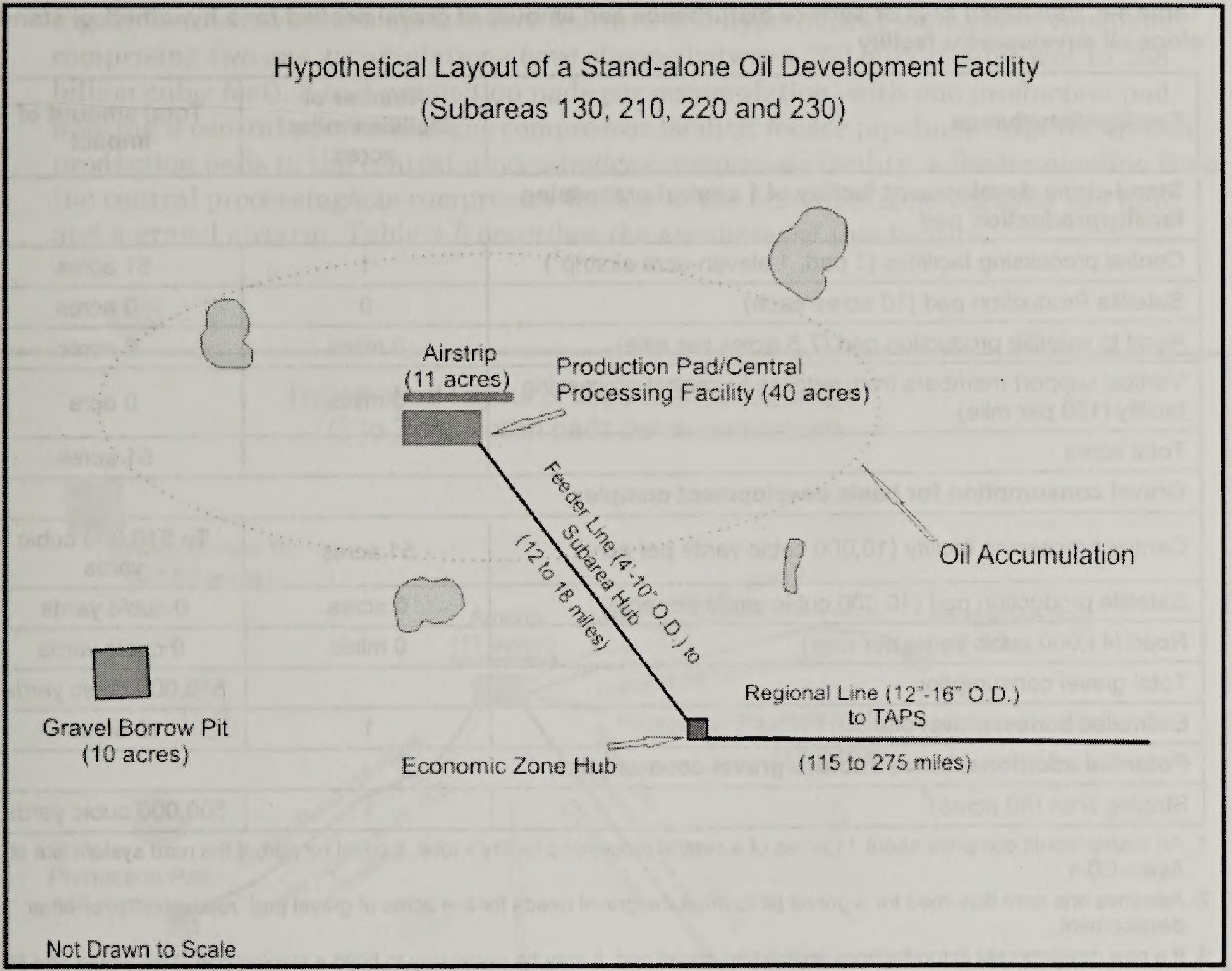
Hypothetical Layout of a Stand-alone Oil Development Facility
(Subareas 130, 210, 220 and 230)
Airstrip
(11 acres)
Production Pad/Central
Processing Facility (40 acres)
Feeder Line (4"-10" O.D.) to
Subarea Hub
(12 to 18 miles)
Oil Accumulation
Gravel Borrow Pit
(10 acres)
Economic Zone Hub
Regional Line (12"-16" O.D.)
to TAPS
(115 to 275 miles)
Not Drawn to Scale

Figure 4—5. Hypothetical layout of a stand-alone oil development facility
(TAPS = Trans-Alaska Pipeline System)

Consistent with USGS's analysis, regional oil pipelines transport oil from economic zones to Pump Station 1 of the Trans-Alaska Pipeline System and regional gas pipelines from the economic zones are directed to a hypothetical hub at Inigok. From Inigok, a 110-mile, high-pressure trunk line transports gas and natural gas liquids to a hypothetical gas conditioning facility near Pump Station 1 of the Trans-Alaska Pipeline System. The USGS assumes that the gas feeder lines from the fields to the economic zone hubs are low-pressure lines, as these will be much shorter than the regional lines and require less capacity. The regional gas pipelines from the hubs in zones 110, 120, 130, and 210 to Inigok are also assumed to be low pressure.

Table 4-4. Estimated area of surface disturbance and amount of gravel needed for a hypothetical stand-alone oil development facility

Facility/disturbance	**Number of facilities/miles/ acres**	**Total amount of impact**
Stand-alone development facility of 1 central processing facility/production pad		
Central processing facilities (1 pad, 1 eleven-acre airstrip[1])	1	51 acres
Satellite Production pad (10 acres each)	0	0 acres
Road to satellite production pad (7.5 acres per mile)	0 miles	0 acres
Vertical support members from satellite to central processing facility (150 per mile)	0 miles	0 acre
Total acres		51 acres
Gravel consumption for basic development complex		
Central processing facility (10,000 cubic yards per acre)	51 acres	To 510,000 cubic yards
Satellite production pad (10,000 cubic yards per acre)	0 acres	0 cubic yards
Road (41,000 cubic yards per mile)	0 miles	0 cubic yards
Total gravel consumption		510,000 cubic yards
Estimated borrow gravel pits[2]	1	10 acres
Potential additional infrastructure/gravel consumption		
Staging area (50 acres)[3]	1	500,000 cubic yards

1. An airstrip would comprise about 11 acres of a central processing facility's total. It could be part of the road system like at Alpine CD-1.
2. Assumes one acre disturbed for a gravel pit to meet the gravel needs for five acres of gravel pad, road, airstrip, or other development.
3. If a new development is too far from an existing gravel pad, it may be necessary to build a staging pad. This would add 50 acres to the gravel footprint and 10 acres to the area disturbed by gravel pits.

No commercial natural gas fields have been developed on Alaska's North Slope, so describing a hypothetical gas field development in the NPR-A is an uncertain proposition. Natural gas does not require a pumping unit or waterflooding and can produce simply from reservoir pressure, but requires separators to remove water and condensates, a gas compressor facility to repressurize the gas once water and condensates are removed, processing to remove contaminants and a pipeline with additional compression stations located on gravel pads to keep the gas moving. In general, gas recovery rates are higher and more efficient than for oil so gas can be extracted from a subsurface area with fewer wells and less infrastructure. Large scale conventional gas development requires about 25 percent of the number of wells per acre as oil production; gas drainage per well averages 640 acres/well compared to drainage for oil of 160 acres per well, and gas processing facility with a gas compressor facility requires less land (about 10 acres for this analysis) than an oil development central processing facility.

Figure 4—6 shows the major surface features of a hypothetical joint gas development comprising two gas accumulations (size classes between 250 billion cubic feet to 768 billion cubic feet), 2 to 3 production pads per accumulation, with one production pad housing a central processing /gas compressor facility; feeder pipelines from the in-field production pads to the central processing/gas compressor facility; a feeder pipeline from the central processing/gas compressor facility to the economic zone regional gas hub; and a gravel airstrip. Table 4-5 describes the attributes of this facility.

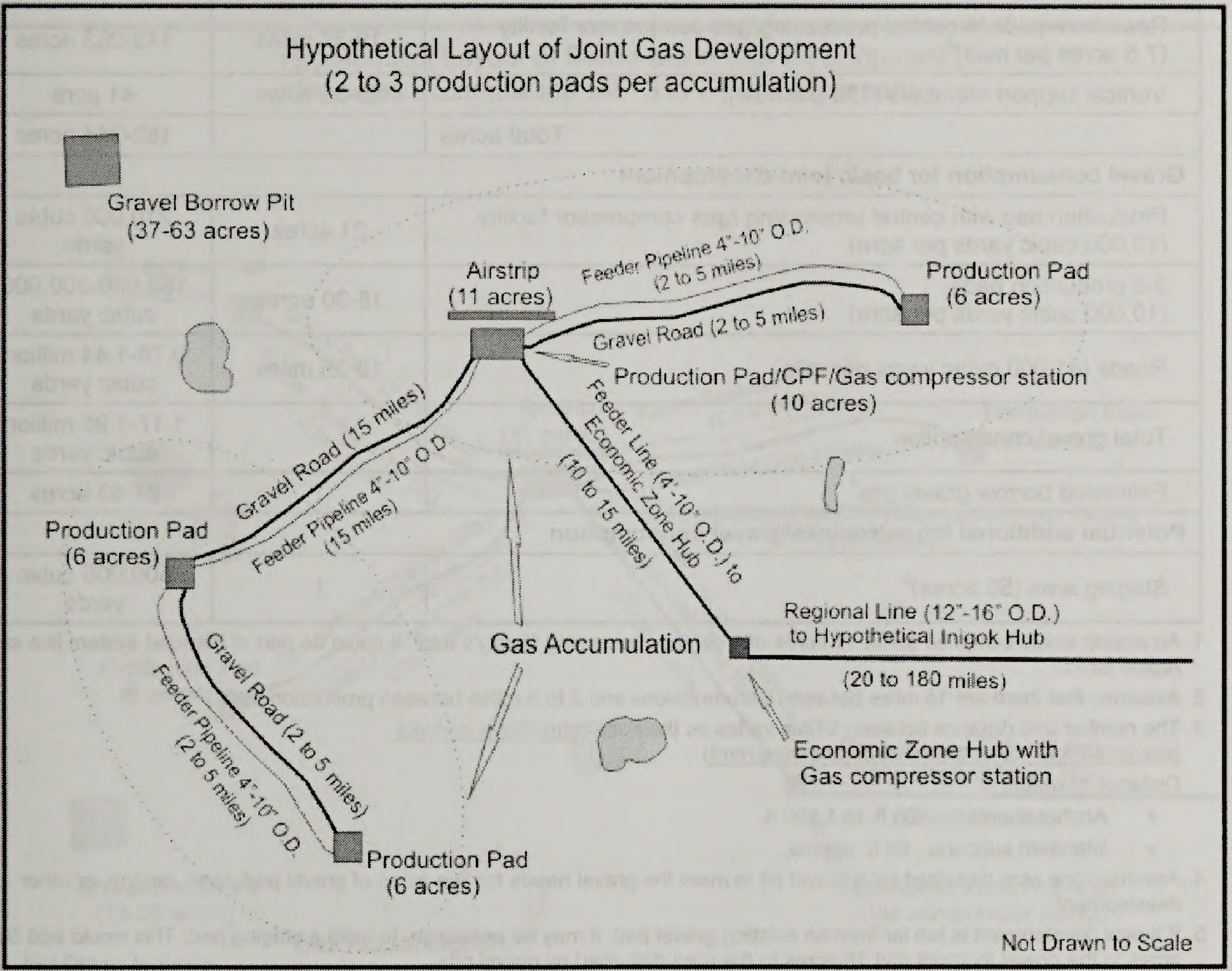
Hypothetical Layout of Joint Gas Development
(2 to 3 production pads per accumulation)
Gravel Borrow Pit
(37-63 acres)
Airstrip
(11 acres)
Feeder Pipeline 4"-10" O.D.
(2 to 5 miles)
Production Pad
(6 acres)
Gravel Road (2 to 5 miles)
Production Pad/CPF/Gas compressor station
(10 acres)
Gravel Road (15 miles)
Feeder Pipeline 4"-10" O.D.
(15 miles)
Feeder Line (4"-10" O.D.) to
Economic Zone Hub
(10 to 15 miles)
Production Pad
(6 acres)
Regional Line (12"-16" O.D.)
to Hypothetical Inigok Hub
(20 to 180 miles)
Gas Accumulation
Gravel Road (2 to 5 miles)
Feeder Pipeline 4"-10" O.D.
(2 to 5 miles)
Economic Zone Hub with
Gas compressor station
Production Pad
(6 acres)
Not Drawn to Scale

Figure 4—6. Hypothetical layout of joint gas development

Table 4-5. Estimated area of surface disturbance and amount of gravel needed for a hypothetical joint gas development

Facility/disturbance	Number of facilities/miles/ acres	Total amount of impact
Joint gas development		
Production pad/ central processing /gas compressor facility (1 pad, 1 eleven-acre airstrip[1])	1	21 acres
Production pad (6 acres each)	3-5	18-30 acres
Road from pads to central processing/gas compressor facility (7.5 acres per mile)[2]	19-35 miles	143-263 acres
Vertical support members (150 per mile)[3]	19-35 miles	<1 acre
Total acres		182-314 acres
Gravel consumption for basic joint development		
Production pad with central processing /gas compressor facility (10,000 cubic yards per acre)	21 acres	210,000 cubic yards
3-5 production pads (10,000 cubic yards per acre)	18-30 acres	180,000-300,000 cubic yards
Roads (41,000 cubic yards per mile)	19-35 miles	0.78-1.44 million cubic yards
Total gravel consumption		1.17-1.95 million cubic yards
Estimated borrow gravel pits[4]	1	37-63 acres
Potential additional infrastructure/gravel consumption		
Staging area (50 acres)[5]	1	500,000 cubic yards

1. An airstrip would comprise about 11 acres of a central processing facility's total. It could be part of the road system like at Alpine CD-1.
2. Assumes that there are 15 miles between accumulations and 2 to 5 miles between production pads.
3. The number and distance between VSMs varies as their use (http://www.alyeska-pipe.com/PipelineFacts/pipelineengineering.html)
   Distance between:
   - Anchor supports - 800 ft. to 1,800 ft.
   - Standard supports - 60 ft. approx.
4. Assumes one acre disturbed for a gravel pit to meet the gravel needs for five acres of gravel pad, road, airstrip, or other development.
5. If a new development is too far from an existing gravel pad, it may be necessary to build a staging pad. This would add 50 acres to the gravel footprint and 10 acres to the area disturbed by gravel pits.

Figure 4—7 on page 31 shows the major surface features of a hypothetical Stand-alone Gas Development comprising one gas accumulation (size classes greater than 768 billion cubic feet) with 2 to 3 production pads, one production pad housing a central processing/gas compressor facility, feeder pipelines from the in-field production pads to the central processing/gas compressor facility, a feeder pipeline from the central processing/gas compressor facility to the economic zone regional gas hub, and a gravel airstrip. Table 4-6 on page 32 describes the attributes of this facility.

Development and operation of oil and gas facilities in the NPR-A may require access across the tundra, off pads or gravel or ice roads. Such access could be necessary to respond to spills or other emergencies; conduct training to respond to potential spills; conduct pipeline inspection, maintenance, and repair; facilitate ice road construction; or transport equipment and supplies to oil developments not connected to the interconnected North Slope gravel road network. Vehicles would conduct these activities from the nearest production or processing facility pads or gravel or ice roads (USDOI BLM 2004b).

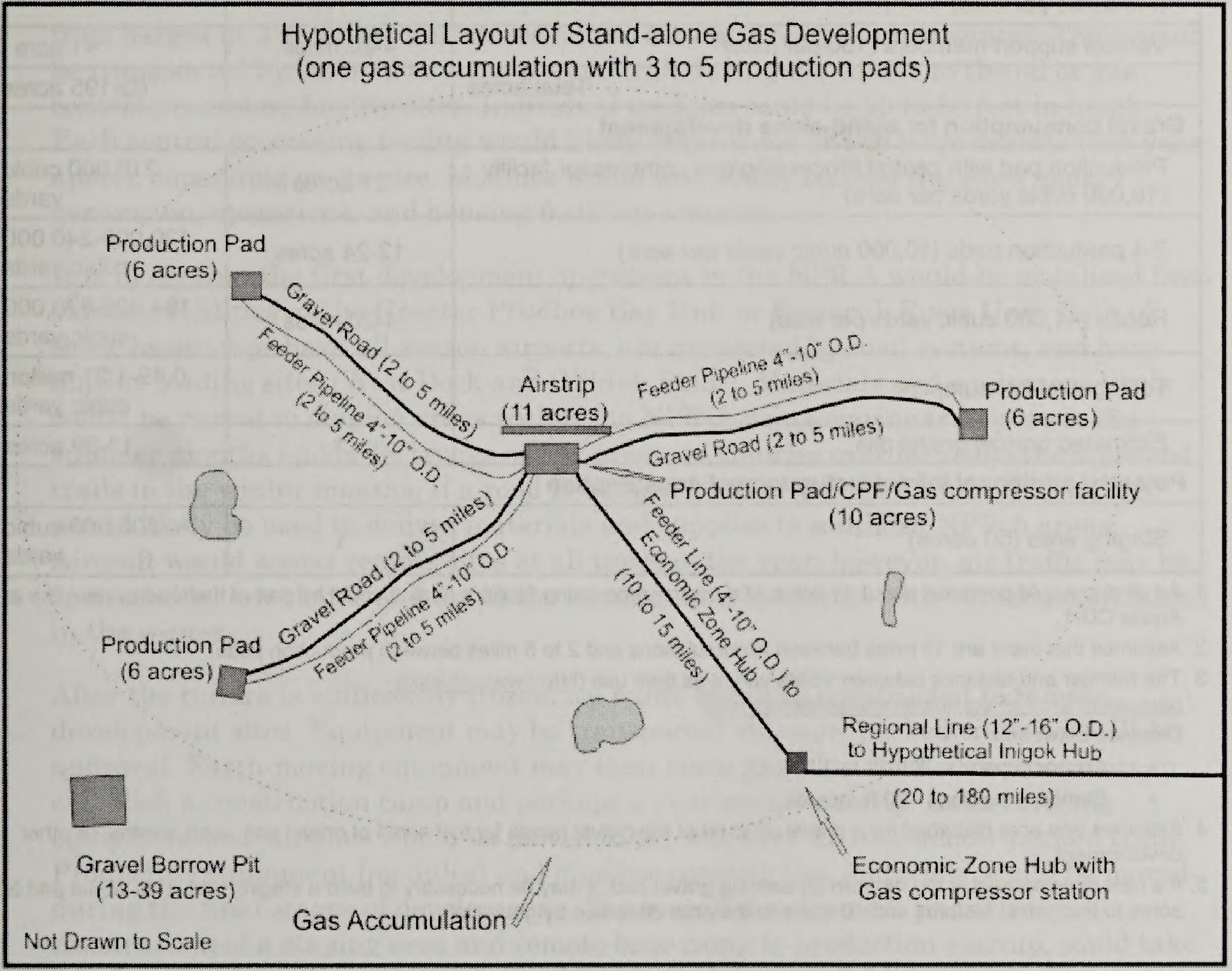
Hypothetical Layout of Stand-alone Gas Development
(one gas accumulation with 3 to 5 production pads)
Production Pad
(6 acres)
Gravel Road (2 to 5 miles)
Feeder Pipeline 4"-10" O.D.
(2 to 5 miles)
Airstrip
(11 acres)
Feeder Pipeline 4"-10" O.D.
(2 to 5 miles)
Production Pad
(6 acres)
Gravel Road (2 to 5 miles)
Production Pad/CPF/Gas compressor facility
(10 acres)
Gravel Road (2 to 5 miles)
Feeder Pipeline 4"-10" O.D.
(2 to 5 miles)
Feeder Line (4"-10" O.D.) to
Economic Zone Hub
(10 to 15 miles)
Production Pad
(6 acres)
Regional Line (12"-16" O.D.)
to Hypothetical Inigok Hub
(20 to 180 miles)
Economic Zone Hub with
Gas compressor station
Gravel Borrow Pit
(13-39 acres)
Gas Accumulation
Not Drawn to Scale

Figure 4—7. Hypothetical layout of stand-alone gas development

Table 4-6. Estimated area of surface disturbance and amount of gravel needed for a hypothetical stand-alone gas development

Facility/disturbance	Number of facilities/ miles/acres	Total amount of impact
Stand-alone gas development		
Production pad/ central processing /gas compressor facility (1 pad, 1 eleven-acre airstrip[1])	1	21 acres
Production pad (6 acres each)	**2-4**	**12-24 acres**
Road from pad to central processing /gas compressor facility (7.5 acres per mile)[2]	4-20 miles	30-150 acres
Vertical support members (150 per mile)[3]	4-20 miles	<1 acre
Total acres		63-195 acres
Gravel consumption for stand-alone development		
Production pad with central processing/gas compressor facility (10,000 cubic yards per acre)	21 acres	210,000 cubic yards
2-4 production pads (10,000 cubic yards per acre)	12-24 acres	120,000-240,000 cubic yards
Roads (41,000 cubic yards per mile)	4-20 miles	164,000-820,000 cubic yards
Total gravel consumption		0.49-1.27 million cubic yards
Estimated borrow gravel pits[4]	1	13-39 acres
Potential additional infrastructure/gravel consumption		
Staging area (50 acres)[5]	1	500,000 cubic yards

1. An airstrip would comprise about 11 acres of a central processing facility's total. It could be part of the road system like at Alpine CD-1.
2. Assumes that there are 15 miles between accumulations and 2 to 5 miles between production pads.
3. The number and distance between VSMs varies as their use (http://www.alyeska-pipe.com/PipelineFacts/pipelineengineering.html)
   Distance between:
   - Anchor supports - 800 ft. to 1,800 ft.
   - Standard supports - 60 ft. approx.
4. Assumes one acre disturbed for a gravel pit to meet the gravel needs for five acres of gravel pad, road, airstrip, or other development.
5. If a new development is too far from an existing gravel pad, it may be necessary to build a staging pad. This would add 50 acres to the gravel footprint and 10 acres to the area disturbed by gravel pits.

2. Staging Areas

All materials and equipment necessary to develop a new field must be stockpiled, moved, and assembled in remote portions of the NPR-A. Consequently, staging areas are very important components of development. Ideally, a staging area contains buildings for warehouses and crew quarters, gravel pads for stockpiling materials, and a serviceable airstrip. Depending on where development occurs, it may also be necessary to develop a staging area on the coast. This may include a causeway or dock for loading materials and equipment transported by barges, though high ground at the former Point Lonely DEW-Line station can be accessed by barge at higher tides. For purposes of this plan, it is assumed that each staging area would be approximately 50 acres.

Considering the expense to establish a new staging area in a remote site, it may be more cost-effective to reoccupy existing sites, even if some refurbishing is necessary, as was done on private land on the Simpson Peninsula for the 2006 FEX L.P. winter exploration operations. Camp Lonely, BLM-administered lands (Cook Inlet Region Incorporated [CIRI] lease site and the former Distant Early Warning-Line station), Inigok, and Umiat have also been used as major staging areas for past NPR-A operations.

Development of staging areas would occur in winter prior to the start of development activities. The number of barges required in each sealift to support development activities would be up to 30 barges per year. Modules and equipment would be offloaded from barges in 3 to 5 days and stored on the staging area pad until winter. They would be transported by ice road or snow-packed trail during the winter to the oil or gas central processing facility sites. Individual modules could be 20 to 30 feet in height. Each central processing facility would likely require one or two large sealifts (one year apart), depending on its size. Modules would eventually become the site's energy generation, operations, and housing facilities complex.

It is likely that the first development operations in the NPR-A would be mobilized from existing facilities at the Greater Prudhoe Bay Unit or Kuparuk River Unit. Both of these basecamps have all-season airports, are connected by road systems, and have marine loading sites (West Dock and Oliktok Point). Materials and equipment likely would be moved to staging areas within the NPR-A using marine transport in the summer months and/or by trucks or low-pressure vehicles over ice roads/snow-packed trails in the winter months. If a road is built to Umiat from the Dalton Highway, it would likely be used to deliver materials and supplies to southern NPR-A areas. Aircraft would access remote sites at all times of the year; however, air traffic may be restricted by low clouds and fog in the summer and by storms with whiteout conditions in the winter.

After the tundra is sufficiently frozen, ice roads would be constructed to remote development sites. Equipment may be transported via snow-packed trails with BLM approval. Earth-moving equipment may then move gravel to the development site to establish a construction camp and perhaps a year-round airstrip. Later, drilling equipment and supplies would be moved to the site over ice roads/snow-packed trails. Production equipment (modules) and pipeline-construction materials would be moved during the final stages of development. The overall development phase, from construction of a staging area and remote base camp to production startup, could take 3 to 7 years, depending on the size and location of the new field.

3. Gravel Requirements

Much of the initial work for a new project would involve the construction of gravel pads for wellheads, production and support facilities, roads, and an airstrip. The development area must be level, stable, and elevated above the wet tundra surface. Because the tundra surface is unstable and, especially in the coastal plain, subject to flooding in summer and ice-jacking forces in winter, pad surfaces are designed to be at least 5 feet above the tundra surface.

Gravel is the preferred material for pad construction. Borrow pits (containing gravel) are relatively common east of the Colville River, but gravel is a scarce commodity in the NPR-A. Industry, government, and academia have been evaluating constructing pads using a variety of stabilization methods, including geotextiles or geogrids, geosynthetic or natural fiber additives, and chemical additives, to stabilize subgravel mineral materials. Such stabilization methods, however, are still undergoing evaluation. In addition, a variety of alternate strategies could be adopted, including the following:

- Extracting gravel from existing mine sites east of the Colville River;
- Developing new sand and gravel mine sites within the NPR-A;
- Barging gravel to coastal staging areas;
- Processing bedrock for construction materials;
- Designing alternatives (year-round ice pads; composite all-season pads); and
- Reusing gravel from previous drill sites.

Several types of gravel pads have been used on the North Slope. Gravel requirements are reduced substantially by composite pad designs in which the lower portions of pads are built using blended (geotextured) mixtures of sand and silt. This lower lift is overlain by rigid, dense foam (Styrofoam) insulation boards and then covered by a layer (2 feet thick) of clean gravel. Surficial deposits used to form the lower section of a pad are available throughout the NPR-A, and could be extracted and blended during winter months from borrow areas near the development site. Use of such a design could reduce the overall gravel requirement by 33 to 50 percent, as compared to use of all-gravel pad designs.

Gravel used for developments in the northeastern portion of the planning area could be extracted from existing or to-be-discovered borrow sites and then transported to the development sites by trucks over winter ice roads. The proposed Clover A Mine Site is located in the NPR-A, approximately 10.8 miles southwest of the Alpine development. This gravel mine site is still in the planning stages and no development has occurred. Investigations by ConocoPhillips Alaska, Inc. concluded that the deposits of suitable sand and gravel material are localized and the site appears to offer the greatest concentration of these deposits in the vicinity of the Alpine Field (USDOI BLM 2004b).

For more distant sites in the central and western portion of the planning area, gravel could be mined from existing borrow pits, barged to coastal staging areas, and stockpiled for later transport by trucks over winter ice roads or snow-packed trails. Sand and gravel could also be extracted from new sites within the NPR-A. In the foothills area of the southern NPR-A, bedrock outcrops could be blasted and then crushed and blended with sand to make up suitable construction material.

For each new gravel site, overburden removal and sand/gravel mining could impact areas of 20 to 50 acres or more, depending on the thickness and extent of the deposit and amount of material extracted. Between 1988 and 2001, approximately 544 acres of North Slope oil field roads and pads were developed from 104 acres of gravel pits and 19 acres of river gravel removal (National Research Council 2003). For this IAP/EIS analysis, an assumption was made that approximately one acre would be disturbed for gravel removal to meet the gravel needs for five acres of oil and gas development (e.g., a 10-acre gravel production pad would result in two acres of borrow pit disturbance.

4. Development and Production Well Drilling

The number of production wells is determined by the unique characteristics of the oil and gas reservoir, such as thickness, permeability, lateral continuity, oil and gas qualities, and, most importantly, the reservoir recover mechanism. Well drainage areas vary for conventional wells, but generally do not exceed 640 acres for gas and 160 acres for oil. Virtually all North Slope production and injection wells are now drilled using horizontal drilling; a method where the well bore penetrates thousands of feet of reservoir strata horizontally and by doing so increases reservoir exposure to the borehole and to production tubing. Production is more efficient and thus less costly on a unit (per barrel) basis. The drainage area and, thus, well productivity assigned to a horizontal production oil well depend on the natural drainage area of vertical wells and the length of the horizontal section of the wellbore that is in contact with the producing formation. For example, if a vertical oil well has a circular drainage area of 160 acres, then a horizontal oil well having a horizontal section of 3,000 feet would theoretically increase the drainage area to 365 acres (Joshi 1991). Later in the life cycle of a field, well spacing typically is reduced by infill drilling (i.e., adding new wells in an existing field) in the attempt to capture more oil reserves as the pressure in the reservoir is depleted.

In addition to production wells, other wells are drilled to inject water or gas into the field to maximize oil recovery. These wells generally are referred to as service (or injection) wells. Numerous injection wells are required for waterflood programs, which are used routinely throughout the production cycle to maintain reservoir pressure. The proportion of producer to service wells can vary for each field, but a typical ratio of producers to service in conventional oil wells is 1:1 (i.e., one-half of the total number of wells are nonproducing service wells). Application of horizontal well technology can reduce the number of production wells required to drain a pool and reduce the number of drilling pads and their sizes. For this IAP/EIS, each producing horizontal oil well is assumed to require a horizontal injection well, as is the case in the Alpine field. Gas accumulations do not require water injection wells and horizontal drilling is not applied to gas field development for this IAP/EIS.

The time required to drill and complete a production well largely depends on the drilled (or measured) depth of the well and the production interval of the completion. On the North Slope, it normally takes approximately 30 to 40 days to drill and complete a 10,000-foot horizontal well, which equates to approximately 9 to 7 wells per rig in a 12-month period. Safety considerations normally restrict operations to one rig drilling on each pad at a time.

5. Drilling Mud and Rock Cuttings

Drilling operations for each development well require large amounts of drilling mud and produce large quantities of rock cuttings. The estimates provided for exploration/delineation wells would apply to development wells of equivalent depths. Based on the design and experience of recent North Slope drilling operations, we anticipate zero surface discharge of wastes in the planning area. Generally, dedicated disposal wells (e.g., approved Class II grind and inject facilities) are used for injection of excess drilling wastes, although it is possible to inject wastes into shallow zones of production wells while allowing oil production from deeper zones. Fifty percent or more of the drilling mud would be reconditioned and reused onsite, reducing the costs of both materials and disposal.

Generally, all wastewater, spent fluids, and chemicals would be disposed of in injection wells approved by the EPA, the Alaska Oil and Gas Conservation Commission, or Alaska Department of Environmental Conservation, depending upon waste characterization. Solid, non-burnable waste would be deposited in large dumpsters or other suitable containers located at each site. These containers would be back-hauled to approved offsite landfills (e.g., North Slope Borough landfill at Prudhoe Bay) or taken to an approved incinerator (e.g., the Kuparuk incinerator at the main central processing facility CPF-1 camp). Normal practices do not allow onsite burial of solid wastes.

6. Water Demand
Water is needed for drilling and camp use. Drilling water demand is estimated to be 21,000 to 63,000 gallons per day, or 420,000 to 1.9 million gallons per well. Water demand for camp use is estimated to be 100 gallons per day per person. Potable water demand would drop after 2 to 4 drilling seasons, when the major construction phase would be finished. Approximately 160 persons would be on site during the production and development phases for each central processing facility and four to six satellite fields (S. Rothwell, ConocoPhillips, pers. comm., February 27, 2007). Drilling-water demand over a 20-year production life of a field (largely for workover operations and infill drilling) would likely be less than the 21,000 gallons per day estimated above.

Production

1. Production Facilities

A central processing facility would serve as the operational center for long-term production activities in a North Slope oil or gas field. In addition to oil or gas production equipment, the central processing facility typically includes living quarters and offices, maintenance shops, storage tanks for fuel and water, power generators, waste-treatment units, a communications center, and compressors for gas and water reinjection. For most North Slope projects, many components of the central processing facility are constructed as transportable modules in offsite locations, perhaps outside Alaska, barged to the North Slope, then moved over gravel roads or winter ice roads to the field and assembled. All buildings are supported above the ground on pilings to accommodate ground settling or frost heaving. An airstrip usually is located near the central processing facility to allow transport of supplies and personnel to the field site.

The central processing facility typically is located on the largest and most central, or initial, development pad. Equipment at the central processing facility is used to separate the materials that are produced from the wells (oil, natural gas, and water) on the pad. The central processing facility would also process produced oil and gas from any smaller, outlying satellite pads. Produced oil is filtered (to remove sand) and processed (to remove water and gas) before being piped through a sales meter and into the sales-oil pipeline system. Associated gas is processed (to remove liquids and impurities), pressurized (compressed), and is re-injected into the reservoir through gas injection wells or sent through a pipeline to market. In the case of a commercial nonassociated gas operation, gas would be processed, sent through a compressor and directly into a gas pipeline to market. Water is processed (chemically treated) and re-injected into the reservoir for pressure maintenance.

Re-injection of produced gas and water helps maintain oil reservoir energy, and improve hydrocarbon recovery efficiency by sweeping oil towards the production wells, increasing the ultimate oil recovery. Associated gas and water injection wells are needed where no gas sales line exists and where water disposal is not allowed at the surface.

2. Production Rates

The production rate from an individual field commonly peaks within 1 to 3 years for oil and 12 to 13 years for gas, depending on production handling design, future satellite field discoveries, reservoir and well performance, and other factors. (Note: To allow consistency with USGS gas production projections, the BLM has assumed that gas production peaks substantially faster than described here.) Production rates would ultimately taper off from a single field as the reservoir pressure is depleted and the recoverable oil or commercial gas is produced. Because development well drilling occurs over several years, the production profile for a field is much broader than for any individual well. Initial production usually occurs when sufficient volumes of oil or gas are achieved to effectively operate conditioning equipment. Production ends when the value of production cannot meet operating expenses.

3. Waterflooding

During production, waterflooding would constitute the major water demand. Waterflooding is a key secondary production practice that can substantially increase oil recovery. Injecting water into selected areas of the reservoir maintains subsurface pressure and promotes fluid flow to the production wells. To maintain reservoir pressure, the volume of oil withdrawn from the reservoir must be replaced with an equivalent or greater volume of water. Therefore, pressure maintenance requires large quantities of water. For example, a field with a daily production rate of 50,000 barrels of oil would require approximately 2 million gallons per day of water (1 barrel = 42 gallons) for balanced waterflooding, given that some volumetric allowances must be made for each fluid under subsurface conditions. At this example production rate, a waterflood program would require approximately 760 million gallons (2,352 acre-feet) of water each year.

Potential sources of water to meet waterflood demands could include nearby deep lakes, though restrictions to withdrawals from surface water sources that are vital to fish and waterfowl limit the use of this source. Water wells could also be drilled below the permafrost layer (up to 1,500 feet thick) and water pumped from subsurface aquifers, but this practice is more costly.

If local freshwater sources are inadequate to meet the demands of waterflood programs, seawater is used. Seawater supplies are virtually unlimited, and unlike freshwater, which must be treated so that it is chemically compatible with the formation into which it is injected, seawater is reasonably compatible (similar chemically) to the brines present in most petroleum reservoirs. Waterflood systems may include a seawater-intake and treatment plant located on the coast and an insulated pipeline from the seawater plant to service wells in the field. Waterflood programs using seawater are initiated from the onset of production for most North Slope oil fields. As the oil field is produced, the volumes of formation water recovered with oil (water cut) increases. In time (5 to 7 years), injection water demands are met by produced formation water, and the seawater-waterflood system is shut down.

The USGS in their analysis of potential economically recoverable oil in the NPR-A assumed that water to enhance recovery of oil would come from existing facilities that currently serve fields in the Prudhoe Bay and Kuparuk River Unit areas. Seawater pipelines would be installed on vertical support members (VSM) for the sales-oil and other service pipelines. With increasing distances inland, expensive heat generators and pump stations could be required to deliver treated seawater to remote fields in the severely cold winter temperatures of the North Slope.

4. Miscible Injection and Fracture Stimulation
In addition to waterflooding, miscible fluid injection is used to maintain pressure in the reservoir and increase the recovery of oil and commercial gas. Miscible injection involves the injection of various types of gases (generally under high-pressure conditions) into the reservoir. The injected gases can include liquefied petroleum gas, methane, hydrocarbon gas mixtures, nitrogen, and CO_2. Hydrocarbon gasses are primarily used on the North Slope because they are produced along with conventional oil and therefore readily available. Lack of a pipeline to markets makes re-injection the best use and conservation of the commodity, since a portion of the re-injected gas would be available for future production and sales. Miscible injection is most commonly referred to as Enhanced Oil Recovery. Miscible injectant may also be injected alternating with water in a single injection well (water-alternating-gas injection).

Fracture stimulation or “fracking” is used to enhance the production of fluids from comparatively tight reservoirs; i.e., reservoirs with low permeability. Its use is common on the North Slope, particularly in oil production from the Alpine oil field and its satellites. After a well has been drilled, a fracture medium is pumped into the well bore. Pressures are increased, sometimes quickly, fracturing the reservoir and providing fluid migration paths. The fracture medium can be water, foam mixtures, or gasses such as nitrogen or even air, depending on the reservoir. Proppants, such as ceramic spheres or plain- or resin-coated sand, are injected with the medium to make sure that the induced fractures stay open. Fracture media are typically about 99 percent water and sand with various, reservoir-specific chemicals comprising the remaining portion. Leakage of fluids or natural gas from hydraulic fracturing activities has been blamed for the compromising ground water quality in areas where it has been used improperly to enhance gas production from tight sands and shales. However, no similar leakage problems have been reported on the North Slope.

Abandonment

At some time in the life of a field, the revenue from production is insufficient to justify the expenses of operation. The end of economic life occurs before all of the recoverable oil and/or commercial gas is extracted from the reservoir. The factors leading to a decision to abandon a field could differ for each field, but declining production rates and oil and gas prices are usually the two key considerations.

Wells are plugged and abandoned as the field matures. Abandonment activities would likely begin stepwise through the life of the field and could last 2 to 5 years after the end of production. Abandonment operations generally include removing all equipment, plugging all wells, restoring the site, cutting well casing at least 3 feet below the surface, and conducting final environmental studies. Leaseholders would be obligated to remove gravel pads and associated gravel roads, though exceptions may be granted for environmental or public purposes. Reclaimed or abandoned pad sites may be revegetated with native species, or revegetated with species that would ultimately be replaced by native vegetation or allowed to bed naturally. Abandonment operations could take place over many years, as revegetation and environmental monitoring studies would continue to document the long-term effects of past operations at a particular site. A series of permitting and inspection activities would be associated with oil and gas field abandonment, and would involve visiting the site as needed until satisfactory revegetation occurred.

The BLM's overall restoration goal for the NPR-A after oil and gas production ceases is to return it to its previous condition and use, which largely includes fish and wildlife habitat. Abandonment and reclamation activities within the NPR-A are governed by 43 CFR Part 3160, subpart 3162, which requires lessees to reclaim the land in accordance with plans approved by the BLM (43 CFR §§ 3162.3-4 and 3162.5-1). Additionally, under all alternatives lease stipulations require the lessee, upon conclusion of operations, to remove facilities and reclaim the land (see Stipulation G-1). All costs associated with abandonment and reclamation are the responsibility of the lessee. BLM regulations require NPR-A lessees to provide financial assurance, in the form of bonds, to ensure compliance with all lease terms, including abandonment and reclamation provisions (43 CFR Part 3130, subpart 3134).

Transportation

1. Regional Oil and Gas Transportation

A regional oil transportation system for the North Slope oil fields was established in 1977 upon completion of the Trans-Alaska Pipeline System. Oil is transported some 800 miles through a 48-inch pipeline to the ice-free port of Valdez, Alaska. From the storage and marine loading terminal at Valdez, oil is loaded onto tankers and transported to U.S. and foreign markets.

The throughput capacity of the Trans-Alaska Pipeline System pipeline plays a significant role in North Slope development. The historic maximum daily throughput capacity of the Trans-Alaska Pipeline System was slightly over 2.0 million barrels per day (achieved in 1988). Maximum average daily throughput as of 2000 was 990,000 barrels per day. In 2011, the Trans-Alaska Pipeline System's throughput averaged 583,000 barrels per day. The minimum throughput for a viable Trans-Alaska Pipeline System operation has been widely debated by government and industry. According to Alyeska Pipeline Company, the Trans-Alaska Pipeline System can continue to be operated safely and with reasonably high operational confidence down to throughputs of about 350,000 barrels per day, assuming a number of issues are addressed (Alyeska Pipeline Company 2012). Industry is well aware of this future problem, and aggressive efforts are underway by North Slope producers to reverse the production decline trend (e.g., shallow viscous oil production (unconventional resources) and stripping condensates from gas. However, as the Trans-Alaska Pipeline System oil volumes decline, higher operating costs are incurred to mitigate critical issues facing safe and efficient pipeline operations. Without this vital transportation system, continued production from the North Slope is unlikely. All NPR-A development scenarios assume that the Trans-Alaska Pipeline System would continue to operate and carry North Slope oil production for decades more into the future. Efforts could include substantial design modifications to handle low (less than 350,000 barrels of oil per day) flow rates. All NPR-A development scenarios also assume construction of a major gas pipeline from the North Slope to a commercial market.

No gas pipeline analogous to the Trans-Alaska Pipeline System exists on the North Slope, but several pipeline projects are under evaluation to bring North Slope natural gas to market. TransCanada, which has entered into an agreement with ExxonMobil, is promoting a large diameter gas pipeline (4.5 billion cubic feet per day) to the Lower 48 through Canada. The State of Alaska is promoting a smaller gas pipeline (1 billion cubic feet per day) to bring gas from the North Slope to Southcentral Alaska via the Fairbanks area. Other projects are under discussion, though permit applications have not been filed.

2. North Slope Pipelines

The central portion of the North Slope contains numerous oil fields connected by pipeline gathering systems to the Trans-Alaska Pipeline System Pump Station Number 1 (Map 3.2.6-2). Because of its location, most new oil development projects in the NPR-A would use the main line between the Kuparuk River Unit and Trans-Alaska Pipeline System Pump Station Number 1. The 24-inch Kuparuk River Unit pipeline has a capacity of approximately 350,000 barrels per day. Excess pipeline capacity could be used by newly developed fields as large fields feeding this pipeline such as Kuparuk and Milne Point decline in production. If oil development occurred in the NPR-A a new pipeline would most likely be constructed from the planning area to the Alpine oil field, and would then connect to the Kuparuk River Unit. This pipeline east of Alpine would likely follow existing pipeline or road right-of-ways and would result in little new surface disturbance. However, other pipeline routes are possible. Development near Umiat or elsewhere in the southern portion of the NPR-A could be linked to the Trans-Alaska Pipeline System along a route parallel to a road proposed by the State of Alaska or by some other southerly route.

3. Future National Petroleum Reserve-Alaska Pipelines

The actual locations of new pipelines in the NPR-A would depend on the location and sequence of commercial-sized discoveries. At present, there is no accurate way of predicting where or when new commercial fields would be discovered and developed. Fields developed early in the future development cycle could establish the first pipeline corridors connecting new planning area fields to existing infrastructure east of the Colville River. Fields developed later in the cycle would be likely to use the existing pipelines, should capacity be available. It is possible that commercial-sized fields discovered by different companies would be shut in (i.e., not produced) until an agreement was reached to share the costs of constructing a pipeline system with developers of other discoveries.

The diameters and lengths of new pipelines in the NPR-A would depend on the characteristics of new fields (undiscovered at present) and, in the context of this plan, on the resource development scenarios for each leasing alternative. Generally, infield oil pipelines (flowlines or gathering lines) carry multi-phase slurries (oil, gas, water) from wellhead manifolds to central processing facilities. Return lines containing gas or water would carry these substances back to injection wells on production pads. Infield flowlines would be relatively small in diameter (4 to 10 inches). Somewhat larger sales-oil pipelines (12 to 16 inches) would carry metered sales-quality oil from NPR-A fields to the Kuparuk River Unit pipeline (24 inches), potentially through the Alpine field, and then on to the Trans-Alaska Pipeline System (48 inches).

Typically, oil pipeline routes are laid out in straight-line segments (or alignments) and are installed aboveground on vertical support members (Figure 4—8). On the North Slope, this installation method is preferred over buried pipelines, because aboveground pipelines take less time to construct, cause less disruption to the land during installation, are easier to monitor and repair, and provide more flexibility for later modification (e.g., adding new pipelines) than buried pipelines.

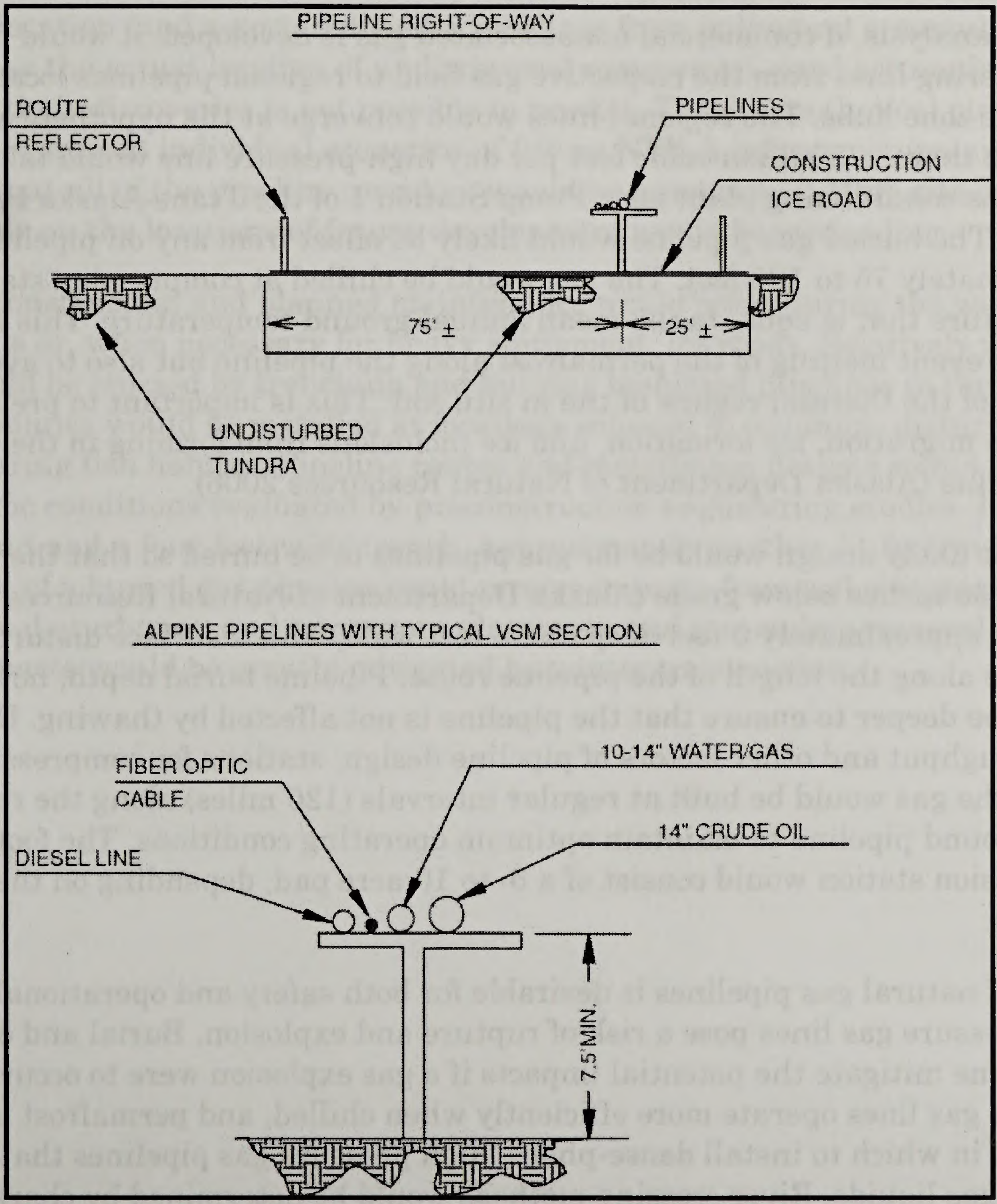
PIPELINE RIGHT-OF-WAY
ROUTE REFLECTOR
PIPELINES
CONSTRUCTION ICE ROAD
75' ±
25' ±
UNDISTURBED TUNDRA
ALPINE PIPELINES WITH TYPICAL VSM SECTION
10-14" WATER/GAS
FIBER OPTIC CABLE
14" CRUDE OIL
DIESEL LINE
7.5' MIN.

Figure 4—8. Sample oil pipeline layout

Typically, vertical support members are spaced 35 to 70 feet apart. Pipelines in recent years have generally been elevated at least seven feet above the tundra. Pipeline clearance is generally higher (up to 20 feet) over topographic lows (stream valleys), because engineering requirements call for a nearly level pipeline route. Small, shallow lakes could be crossed by elevated vertical support members, whereas large or deep lakes would have pipeline vertical support members routed around their shorelines with some setback. Pipelines crossing large rivers, such as the Colville River, could be on bridges or buried using horizontal directional drilling techniques. For example, the three-phase pipeline proposed by ConocoPhillips Alaska, Inc. to deliver resources for processing at the Alpine central processing facility would be on a bridge, while the oil pipeline from Alpine passes under the Colville River. Elevated pipelines would likely cross narrow streams on suspension spans to minimize impacts to streambanks and riparian vegetation and to avoid potential problems associated with corrosion, maintenance, and abandonment of buried pipelines. Pump stations could be required along the new mainline route, depending on distances, pipeline diameters, and production rates. Powerlines would be placed in cable trays on vertical support members or suspended from vertical support members.

For this analysis, if commercial nonassociated gas is developed, it would be transported via gathering lines from the respective gas field to regional pipelines located at economic zone hubs. The regional lines would converge at the hypothetical Inigok hub and from there, a 3 billion cubic feet per day high-pressure line would take gas to a future gas conditioning plant near Pump Station 1 of the Trans-Alaska Pipeline System. The buried gas pipeline would likely be offset from any oil pipeline by approximately 75 to 100 feet. The gas would be chilled at compression stations to a temperature that is equal to the mean annual ground temperature. This is intended not just to prevent melting of the permafrost along the pipeline but also to avoid any changes of the thermal regime of the in situ soil. This is important to prevent long-term moisture migration, ice formation, and ice inclusions from forming in the soil around the pipeline (Alaska Department of Natural Resources 2006).

The most likely design would be for gas pipelines to be buried so that the top of the pipe is about 30 inches below grade (Alaska Department of Natural Resources 2006) in trenches approximately 5 feet deep and 4 feet wide, with a surface disturbed area 15 feet wide along the length of the pipeline route. Pipeline burial depth, however, may need to be deeper to ensure that the pipeline is not affected by thawing. Depending on the throughput and other factors of pipeline design, stations for compressing and cooling the gas would be built at regular intervals (120 miles) along the route of the underground pipeline to maintain optimum operating conditions. The footprint of the compression station would consist of a 5- to 10-acre pad, depending on the design of the facilities.

Burial of natural gas pipelines is desirable for both safety and operational reasons. High-pressure gas lines pose a risk of rupture and explosion. Burial and offset from the oil pipeline mitigate the potential impacts if a gas explosion were to occur. High-pressure gas lines operate more efficiently when chilled, and permafrost is a good material in which to install dense-phase, high pressure gas pipelines that entrain natural gas liquids. River crossing methods would be determined by characteristics of the river; where elevated spans would be used across narrow, deep rivers, burial in trenches is likely to be used across wide, shallow rivers, and horizontally drilled tunnels could be used across wide, deep rivers.

The State of Alaska, however, in its study of a potential gas pipeline near the coast east of Prudhoe Bay, considered both a buried gas pipeline and one that would be elevated on vertical support members. The State considered an aboveground gas pipeline more appropriate for low-volume gas pipelines and in cases in which burial created hydrologic challenges in crossing many drainages. (ADNR 2006; Thompson 2007) If an aboveground gas line was constructed in the NPR-A, it is assumed that it would either be placed on the same vertical support members as a sales oil pipeline or on a separate set of vertical support members. To minimize caribou movement disruption, an aboveground gas pipeline on a separate set of vertical support members would be separated from any other set of vertical support members by at least 500 feet and be elevated the same height as an oil pipeline.

Based solely on USGS geologic play potential and USGS cost assumptions (Attanasi and Freeman 2011), Figure 4—9 and Figure 4—10 represent speculative regional pipeline corridors in the NPR-A. No implications regarding specific hydrocarbon prospect location (and associated feeder pipelines from individual accumulations) is intended as the actual location of undiscovered commercial-sized accumulations and the timing of their discoveries is not possible to predict. These hypothetical pipeline corridors represent individual scenarios of future NPR-A infrastructure, and it is highly unlikely that all of the pipeline corridors would be constructed. More site-specific discussions on the locations of future development would be misleading.

Pipeline construction and planned maintenance would occur during the winter, using snow trails or, when necessary for heavy equipment, ice roads. Relatively wide, shallow rivers could be crossed by trenching and burying insulated pipelines in the riverbed. These pipelines would be installed at locations selected to minimize disturbance to overwintering fish habitat. Pipeline routes and installation designs would depend on site-specific conditions evaluated by preconstruction engineering studies. In addition to the ice road and a four-foot-wide trench, approximately another 11-foot-wide area along the length of a buried gas pipeline could receive impacts from soil compression, vegetative disturbance, and temporary placement and incomplete removal of backfill. These impacts would be greatly mitigated by winter construction.

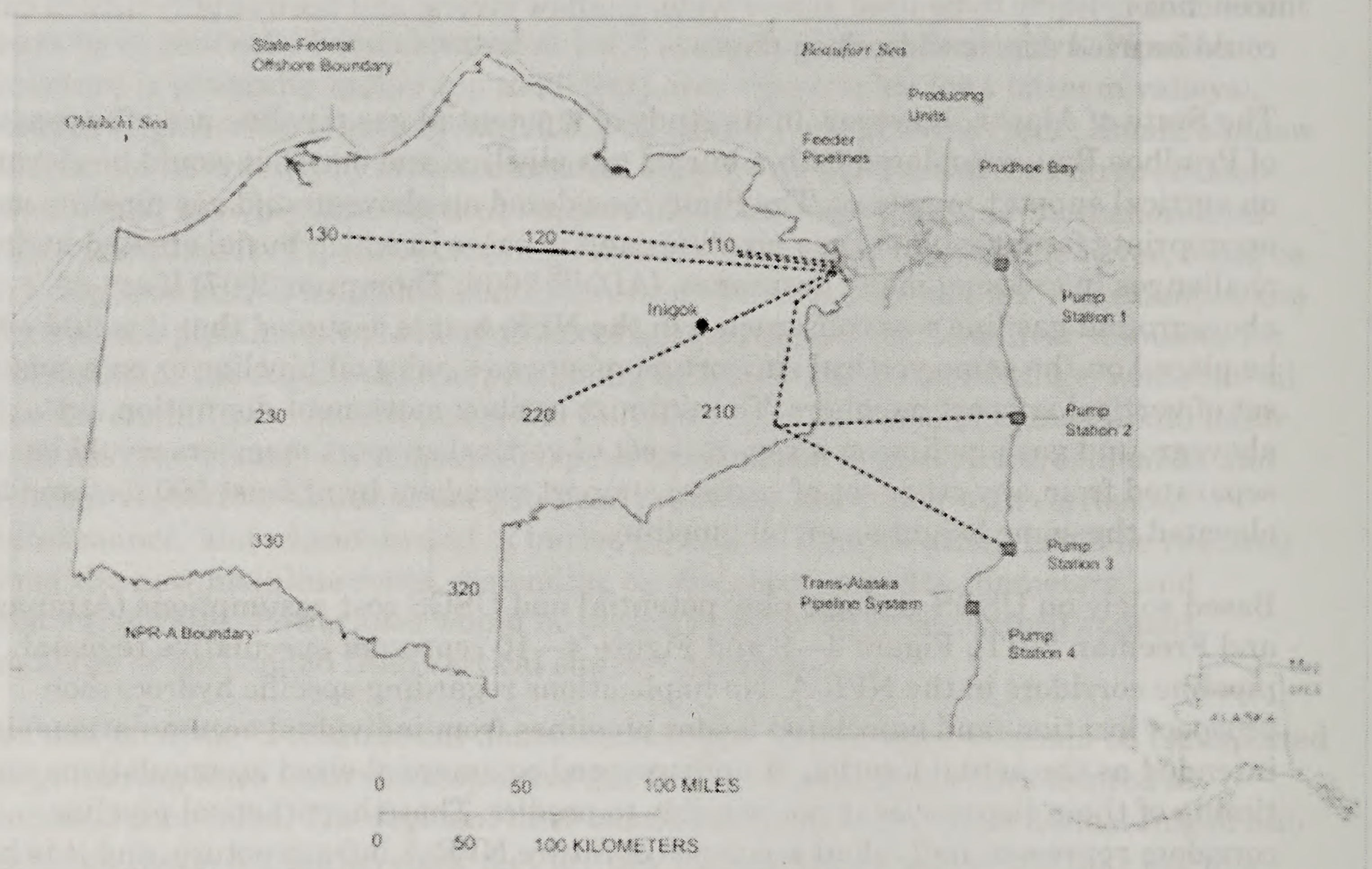
State-Federal Offshore Boundary
Beaufort Sea
Chukchi Sea
Producing Units
Feeder Pipelines
Prudhoe Bay
130
120
110
Inigok
Pump Station 1
230
220
210
Pump Station 2
330
Pump Station 3
320
Trans-Alaska Pipeline System
NPR-A Boundary
Pump Station 4
Map Area
ALASKA
0
50
100 MILES
0
50
100 KILOMETERS

Figure 4—9. Speculative future oil pipeline corridors. (Note: Three pipeline corridor options are displayed for Umiat oil. Economic zones 320 and 330 have no projected economic oil at $180 per barrel). Economic Zone 230 has economic oil at $180/barrel but oil accumulations for each size class have less than a 51 percent probability of occurrence and were subsequently eliminated from resource estimates.

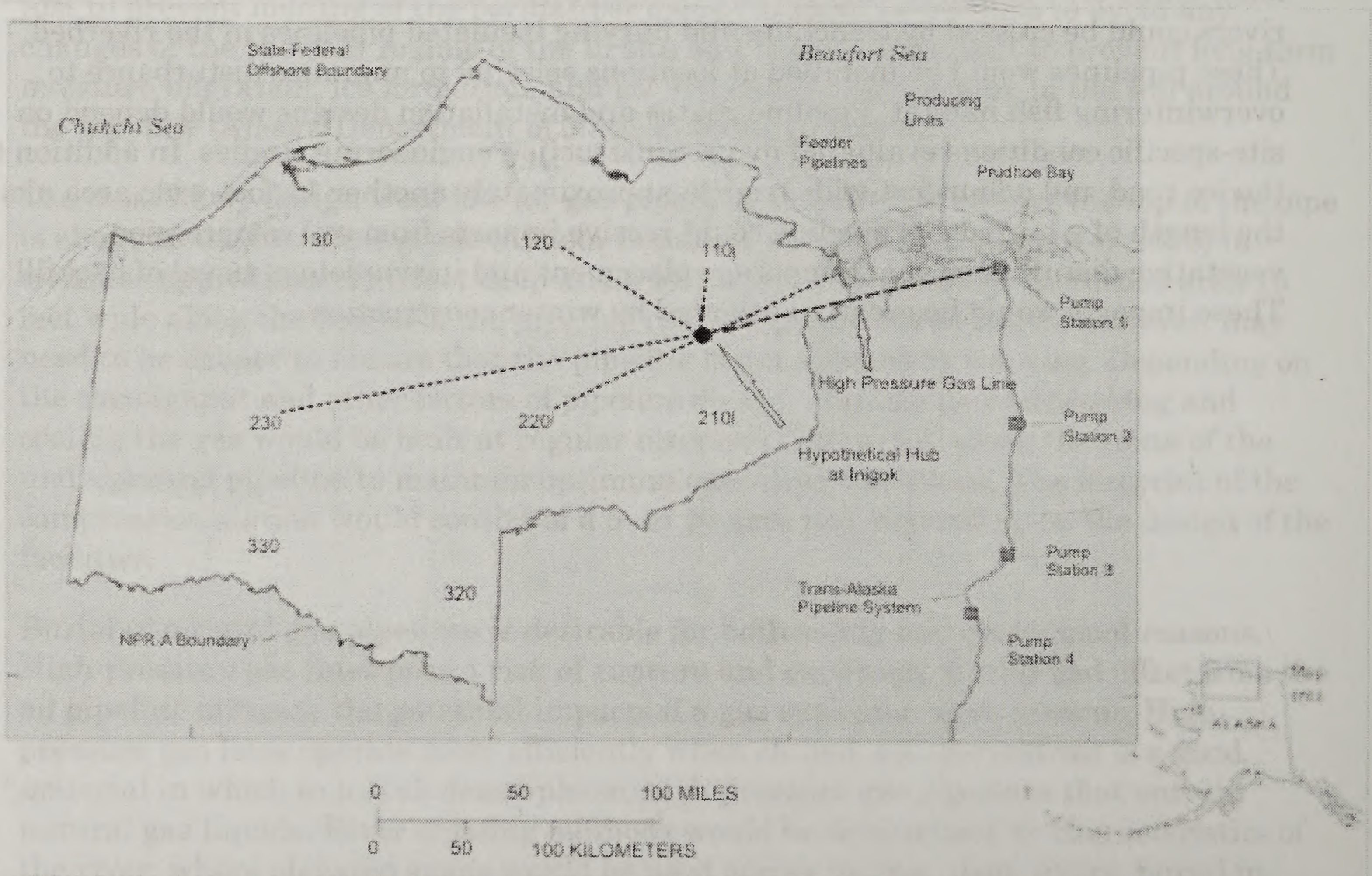
State-Federal Offshore Boundary
Beaufort Sea
Chukchi Sea
Producing Units
Feeder Pipelines
Prudhoe Bay
130
120
110
Pump Station 1
High Pressure Gas Line
230
220
210
Pump Station 2
Hypothetical Hub at Inigok
330
Pump Station 3
320
Trans-Alaska Pipeline System
NPR-A Boundary
Pump Station 4
Map Area
ALASKA
0
50
100 MILES
0
50
100 KILOMETERS

Figure 4—10. Speculative future gas pipeline corridors. (Note: Economic zones 130, 320, and 330 have no projected economic gas at $8.67 per thousand cubic feet.)

4. Roads

Both economic and environmental concerns have led oil companies to minimize gravel road construction on the North Slope. The Alpine field, for example, includes roads linking its central processing facility, most satellite production pads, and an airstrip. While not completely "roadless"—a term sometimes used to describe developments such as Alpine and Badami—these complexes are not linked by gravel road to the major North Slope facilities that are linked by the spine road to the Dalton Highway. It is assumed that future activities in the NPR-A would follow the example of these development projects for several reasons:

- The small (oil) to modest (gas) accumulations predicted for the NPR-A probably could not support the high cost of long, gravel roads;
- The availability of road-construction material (gravel) is likely to be limited in the planning area, particularly on the coastal plain;
- Field construction activities normally are scheduled for the winter months, when overland travel is possible and wildlife presence is lower; and
- Smaller fields in the NPR-A would not require the same level of supply/service operations as multibillion-barrel fields, such as Prudhoe Bay and Kuparuk River Unit.

Winter ice roads or snow-packed trails would connect most fields to allow transport of heavy equipment and supplies to outlying locations. These seasonal roads would be used for 4 to 5 months each winter (December to April). In addition, remote fields would use alternate transportation systems, such as marine barging and/or airstrips for year-round access. Gravel roads could be developed to link production pads between nearby fields that share a central processing facility (see Figure 4—4 on page 25 and Figure 4—6 on page 29).

Based on ice road utility regarding exploration efforts to date in the NPR-A, it is assumed for the purposes of this analysis that 50 miles of ice roads/snow packed trails would be constructed in the NPR-A annually. This incorporates the phased approach for discovery and development projected under each alternative. Once pad construction and development are completed, air transportation of maintenance equipment and personnel to the development complex via a gravel airstrip located at the central processing/gas compressor facility will suffice, and the necessity of building ice roads will be limited to circumstances in which air transport is not feasible or cost-effective.

Ice roads/snow packed trails would also be used to support construction of projected sales pipelines transporting oil and gas from the respective development complexes in the NPR-A to transmission pipelines east of the NPR-A border. Pipelines would be constructed in winter. Under Alternative A, for example, it is assumed that 774 miles of sales oil and nonassociated gas pipeline will be constructed using an equal number of ice road miles.

From a safety standpoint, gravel roads would allow direct monitoring of pipelines and more rapid response time, should repairs be necessary. However, "roadless" development would not preclude access for pipeline inspection; rather, the mode of transportation would change with the seasons. During the winter months, visual inspections could be conducted using nearby ice roads, by snowmachines where ice roads were not present, and by aircraft. In summer months, visual inspections would be conducted primarily using aircraft and possibly low-ground-pressure vehicles. It is likely that pipeline repairs would involve the same forms of transportation. Hovercraft might be used for emergency repair work, particularly during periods when the tundra is wet (as opposed to frozen). Should an emergency pipeline repair be necessary, an on-site coordinator would consider the tradeoffs associated with various remediation strategies.

It should be noted that pipeline monitoring on the North Slope is now done largely using remote instrumentation, and in some cases with the use of smart pigs and maintenance pigs. Numerous monitoring and safety systems are installed to provide redundancy in these electrical and mechanical safety systems. In addition, mechanical shutoff valves are being replaced by vertical expansion loops to provide a more failsafe method of controlling pipeline pressures and leaks.

5. Summer Tundra Travel

Although travel off gravel pads is easiest in winter and generally environmentally preferable at that time, some vehicle travel off pads does occur in North Slope oil fields during the summer to accomplish specific tasks. The State of Alaska has approved some low-ground-pressure vehicles for summer tundra travel after July 15. Similar summer tundra travel may be anticipated to be part of oil production operations in the NPR-A.

Summer vehicle tundra travel is commonly associated with spill prevention and preparedness measures required in spill prevention plans. Each summer season, low-ground-pressure vehicles might be used to transport and place floating booms across streams downstream from pipelines. These booms are left in place through the summer to capture any oil that might spill from a pipeline and then would be retrieved; again probably using low-ground-pressure vehicles, before freeze-up. Pipeline inspections may also entail summer vehicle travel on the tundra. Finally, periodically spill response training may occur along and downstream from pipelines in summer.

Resource Potential and Petroleum-related Activities

A variety of activities is associated with petroleum development, beginning with tract leasing and concluding decades later with abandonment of depleted fields. For the purposes of environmental analysis in this IAP/EIS, the BLM has developed a set of hypothetical development scenarios. The scenarios are based primarily on an assumption that the availability of gas pipeline capacity for the transportation of gas is delayed for a 20-year period. Because some geologic oil and gas plays were assessed to have both oil and gas, the USGS predicted that oil deposits are expected to be found in the process of gas exploration within the NPR-A. These oil deposits are not sufficiently large to drive exploration, but could be commercial if tied to large gas discoveries (once exploration costs are expended) (Attanasi and Freeman 2011). Typically, larger and more profitable fields are discovered early in the exploration cycle. Smaller and less profitable fields may not be of interest to companies driven by profit motives. Companies may view the geologic or economic opportunities differently, and industry perceptions of economic potential may differ from those represented in our scenarios. Readers should be aware that development might differ significantly from the BLM's hypothetical scenario. The general scope and nature of the activity is, however, based on the best and most current information available and is presented here as a representation of possible future activities. In order to develop a reasonable scenario and allow the reader to understand the rationale, the BLM is required to make assumptions.

Assumptions

There are many uncertainties associated with projecting future petroleum exploration and development. These uncertainties include the amount and location of technically recoverable oil and gas; the timing of oil and gas field discoveries and associated development; the future prices of oil and gas and, more to the point, the many exploration companies' individual assessment of future prices and other competitive calculations that play into corporate investment decisions; and the geologic acumen shown by industry to find petroleum and their ability to mobilize the requisite technology to exploit it.

To address these uncertainties, the BLM has made reasonable assumptions based on the 2011 USGS NPR-A economic assessment by Attanasi and Freeman, on its own knowledge of the largely undiscovered petroleum endowment of the planning area and current industry practice, and on professional judgment. In making these assumptions, BLM has striven to minimize the chance that the resultant impact analysis will understate potential impacts. A couple assumptions are key. First, the price assumptions described in Table 4-9 are at the upper level of current government projections. Second, the amount of infrastructure that would be necessary to develop that amount of oil and gas is estimated at upper, but reasonable, limits. For example, it is assumed that each satellite production pad would require a 10- to 15-mile gravel road and pipeline of equal length, though the experience as ConocoPhillips develops the Alpine field would suggest that on average road and pipeline distances would not be so large.

Additional assumptions, some of which also tend to support an optimistic set of development scenarios, include:

- Multiple lease sales would be held.
- Economic conditions (particularly oil and gas prices) would be high enough to support development in northern Alaska.
- Industry would aggressively lease and explore the tracts offered, which could require large numbers of exploration wells.
- Several industry groups will independently explore and develop new fields in the NPR-A.
- Undiscovered oil deposits located outside economic zones 110 and 120 will be found in the process of gas exploration and some will be commercially developed as stand-alone fields.
- Each producing horizontal oil well is assumed to require a horizontal injection well.
- Estimates of the number of oil production wells for a typical prospect are based on Table A3-2 for oil and Table A3-3 for gas in Attanasi and Freeman (2011) and on the assumption that the conventional well drainage area is 160 acres.

- If a vertical oil well has a circular drainage area of 160 acres, then a horizontal well having a horizontal section of 3,000 feet would theoretically increase the drainage area to 365 acres.
- Horizontal drilling technology is not applied to gas field development consistent with the assumptions by Attanasi and Freeman (2011).
- Gas accumulations do not require water injection wells.
- No commercial value is attached to associated gas in an oil reservoir; the USGS projects that the amount of technically recoverable associated gas would be very small (Attanasi and Freeman 2011) and that amount would be further reduced through its use to enhance oil recovery and to power oil development facilities, and the remaining amount would not be sufficient to economically develop the associated gas infrastructure (e.g., gas pipeline and compressor) and operate the fields.
- Technology currently in use to extract oil and gas would remain substantially unchanged.
- New geologic information would confirm the present assumptions, future drilling would generally confirm what today are perceived as high-potential plays, and few, if any, new high-potential plays would be discovered.
- Discovered oil and gas in federal subsurface in the Greater Mooses Tooth and Bear Tooth units would be developed as satellites to the Alpine field and that discovered oil near Umiat would also be produced.
- Future petroleum production would use existing North Slope infrastructure, most importantly the Trans-Alaska Pipeline.
- A major gas pipeline would be constructed from the North Slope to a commercial market.
- For the purposes of this analysis, the following timing assumptions have been adopted:
    - About 20 years of exploration, proving, permitting, facility and pipeline construction, and development drilling would precede initial production of undiscovered oil, though the BLM acknowledges that it is possible that several large oil finds are made and developed in a short period, or that no economic finds are made for a period extending beyond 20 years.
    - Commercial gas production from the NPR-A would not occur for approximately 20 years. In addition to exploration and proving of undiscovered gas in the NPR-A, all NPR-A gas production would await permitting and infrastructure development, including completion of a North Slope gas pipeline system there currently is no pipeline to transport North Slope gas to market. Moreover, there is abundant gas closer to the presumed northern terminus of a future commercial gas pipeline than that in the NPR-A.
    - Production of undiscovered economic oil and nonassociated gas production will occur over an additional 10- to 50-year period, due to the remote location of the planning area, the limited availability of equipment and personnel on

the North Slope, regulatory requirements, and anticipated pipeline capacity. Moreover, there is considerable economic benefit in bringing production online gradually to assure long-term maximum utilization of pipeline capacity.

- ○ Discovered oil in the Greater Mooses Tooth and Bear Tooth units and near Umiat may begin production in less than 10 years.
- ○ Development activities associated with multiple future sales would continue and industry would require time to thoroughly evaluate existing leases before additional tracts would be leased. The complete inventory of petroleum resources in the NPR-A could take many decades to quantify. Twenty-nine exploratory and delineation wells have been drilled on NPR-A tracts leased since 1999 with reports of discoveries of oil and gas from five of those wells. However, a dozen years after that lease sale, no construction to develop oil from these tracts has occurred and it is still not certain if the discoveries are commercially viable.

This IAP/EIS does not anticipate any unconventional oil and gas development in the NPR-A. There currently is no unconventional oil and gas production on Alaska's North Slope so the technology and commercial viability has not been proven in this high-cost Arctic setting. Source rock production, such as of oil from the Bakken Formation in North Dakota, and gas from the Marcellus Shale in the northern Appalachians, is a relatively new innovation in petroleum recovery. The USGS published its first analysis of these resources on the North Slope in February 2012 (Houseknecht et al. 2012). The USGS report and other available information suggests that potential for such resources exists in the NPR-A. Yet the geologic setting on the North Slope may be very different from successful shale oil and shale gas source rocks in the Lower 48 in age, depositional environment, and composition. Present knowledge suggests that NPR-A unconventional source rock oil potential is likely lower, particularly for oil, than for the Bakken. Indeed, some available geologic information indicates that the potential for unconventional oil recovery in NPR-A is less than on State lands farther to the east where geologists believe the source rock that yielded the oil of Prudhoe Bay and the other large conventional oil fields exist. For example, while the USGS's 2012 assessment indicates that Shublik formation shale oil may exist both within and to the east of NPR-A, it estimates that Brookian formation shale, which accounts for nearly half of the technically recoverable shale oil on the North Slope, is far more prospective east of NPR-A. It notes that all of highest potential areas for Brookian shale oil as indicated by the thickness of high gamma ray log responses lie well east of the Reserve, much of it east of the Dalton Highway (USGS 2012b).

Development of unconventional oil and gas in the NPR-A is also severely challenged by logistics and economics. Gravel drilling pads for the unconventional Bakken oil development and other Lower 48 unconventional developments are placed approximately one per 640-acre section and Great Bear Petroleum, LLC, which has bought state lease tracts near the Dalton Highway, initially anticipated similar pad spacing (Petroleum News, May 1, 2011). Great Bear, however, is also considering a strategy of drilling from one or two four- to six-acre pads per nine-square-mile lease tract (Edward Duncan to Louis Niglio, September 10, 2011). It is uncertain whether unconventional development could match some North Slope conventional developments that drain as much as 45 square miles from a single 10-acre pad. In addition to the potential need for more pad acreage, and thus gravel, than conventional development for pads, unconventional oil and gas development is likely to require roads linking all pads (Petroleum News, March 20, 2011). This is because fracture stimulation (fracking) a single source rock well requires a more massive staging of materials and equipment than is typical for North Slope conventional wells. Once producing, recovered oil or gas from unconventional source rock will likely need to be transported by truck because the low yield of such operations would make use of a pipeline economically problematic except in extremely prolific fields. Yet building roads, particularly in the coastal plain of the NPR-A where current information suggests the greatest potential for unconventional oil and gas in the Reserve exists is particularly challenging because of the paucity of gravel sources.

While the gravel needs for recovering unconventional source rock petroleum will make development in the NPR-A expensive, so does the fracking required for unconventional wells. As recent as unconventional development technology is, fracking and horizontal drilling are commonplace on the North Slope today. The Alpine sands are horizontally drilled to about 6,000 feet and commonly fractured in six stages. But because unconventional source rocks are much tighter than conventional reservoirs, much higher fracture pressures, larger volumes of water and proppants, and many more stages of fracking are needed to successfully develop source rocks. As a result, current unconventional fracking operations make up about half the total cost of a well. Unconventional source rock wells in the Lower 48 cost two or more times as much to drill as conventional wells, and available data show that conventional wells on the North Slope are roughly two times more expensive than conventional wells cost in the Lower 48. This means that drilling and fracking operations on the North Slope could cost four times that for conventional oil and gas operations in the Lower 48, which could severely decrease the chance for commercial development.

Adding to the financial challenge is the comparatively limited recovery rate of source rock resources per well. Production from source rocks declines much quicker than from conventional wells. An Alpine conventional oil well initially produces anywhere from 2,000 to 12,000 barrels per day. Typically these rates decline to about 1,000 barrels per day after three years and ultimately produce over 5 million barrels of oil per well on average. By comparison, successful Bakken unconventional wells, some of the most productive unconventional oil wells in existence, are anticipated to ultimately produce 500,000 barrel on average—a tenth as much as the typical Alpine conventional oil well. Bakken wells initially produce around 1,000 barrels per day and drop within 1 to 3 years to just 55 to 70 barrels a day, requiring a pump. The USGS projects mean ultimate recovery rates on the North Slope that are roughly a tenth of that of the Bakken field—43,000 to 61,000 barrels per well for the Brookian and Shublik formations, respectively. The economics for unconventional gas production would be much worse as gas is currently worth around 30 percent as much as oil on a barrel of oil equivalent basis and is expected to remain substantially less valuable than oil through at least 2035, while development costs would be about the same.

Unconventional oil and gas development in the Lower 48 has developed to be a potentially important energy source, though many technical and environmental hurdles remain. There is speculation about whether it will have a future in Alaska, but to date there is no ascertainable trend to indicate that it is developable on the North Slope, much less within NPR-A. Given the comparatively low potential unconventional oil resources in the NPR-A both in comparison to the Lower 48 and to areas near Prudhoe Bay and existing infrastructure, the logistical challenge of creating extensive infrastructure in an area of poor gravel sources, and the large costs for what seems likely to be a small return even compared to other petroleum source rock in the Lower 48 and near Prudhoe Bay, the BLM considers unconventional source rock oil and gas production from the NPR-A a remote and highly speculative result of any decision it might make in this planning effort.

Development Scenarios by Alternatives

This section describes the scenarios of potential development of discovered and undiscovered oil and gas in the NPR-A under the five alternatives. First, descriptions are provided of the development that could occur from discovered petroleum resources in the Greater Mooses Tooth and Bear Tooth units and at Umiat. In this analysis, the potential development of these resources does not differ among the alternatives. Then the analysis turns to projections of potential development of undiscovered oil and gas in the NPR-A. Depending upon the requirements of the alternatives, different scenarios are developed for their development.

1. Development of Discovered Oil and Gas within the Greater Mooses Tooth and Bear Tooth Units

Lookout, Pioneer, and Spark-Rendezvous comprise three, potentially commercial-size oil and gas discoveries located in the northeast NPR-A. These discoveries were not included in the 2010 USGS assessment of undiscovered technically recoverable oil and gas resources of the NPR-A (Figure 4—11, page 52). Lookout and Pioneer are oil accumulations with little or no associated gas. The Spark-Rendezvous accumulation is a large reservoir system that includes gas plus condensate at shallower depths in the north and oil at greater depths in the south (Houseknecht et al. 2010). The USGS estimates that 120 to 200 million barrels of oil (including oil and condensate) and 1.9 to 3.0 trillion cubic feet of gas may be technically recoverable from these accumulations, from the Alpine West discovery on private lands directly to the east, and from inferred discoveries (i.e., an NPR-A accumulation not announced as a discovery by Industry) at Mitre, Scout, and Hunter. With the exception of Alpine West, all of these discoveries are located in the Greater Mooses Tooth or Bear Tooth units. For this analysis, the two units are projected to be developed as satellites to the Alpine oil field. The BLM is assuming that up to 120 million barrels of oil and 1.5 trillion cubic feet of gas would be economical to produce from the discoveries in the Greater Mooses Tooth and Bear Tooth units.

Similar to the existing Alpine satellites, the NPR-A discoveries, including inferred discoveries, would be developed from remote drill pads 10 acres in size. The surface disturbance footprint from gravel pads and pipelines would be similar to the existing Alpine satellite fields Nanuq (CD-3) and Fiord (CD-4). To maximize development efficiencies, NPR-A satellites would be developed in sequence with equipment and materials moving in a stepwise manner from completed activities at one satellite to the next. Some associated gas production may occur, but its infrastructure would be included with oil development scenarios. Any associated gas usage likely would be used to facilitate oil recovery and not for commercial use.

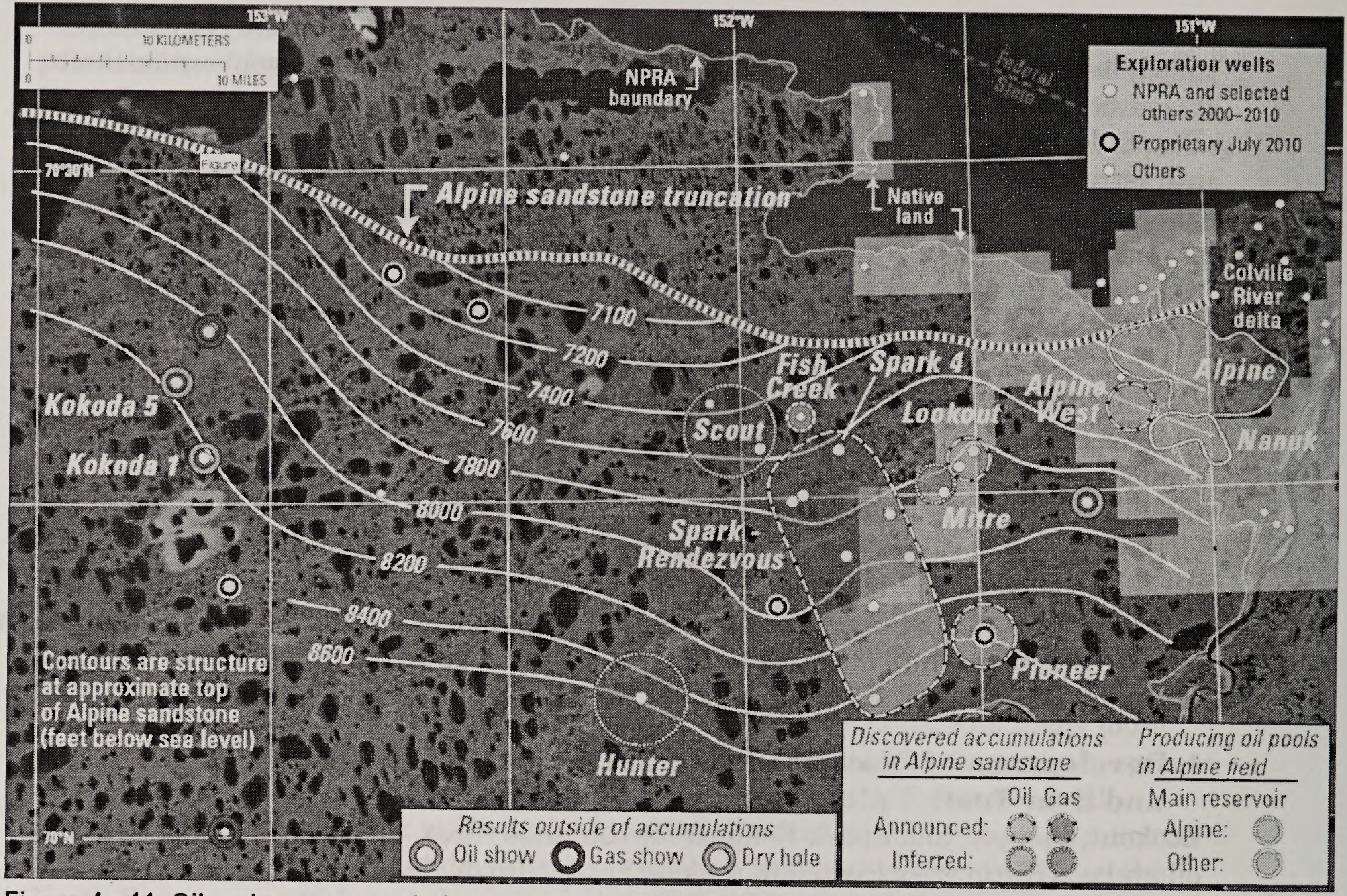
153°W
152°W
151°W
0 10 KILOMETERS
0 10 MILES
NPRA boundary
Federal
State
Exploration wells
NPRA and selected others 2000–2010
Proprietary July 2010
Others
70°30'N
Figure
Alpine sandstone truncation
Native land
Colville River delta
7100
7200
7400
7600
7800
8000
8200
8400
8600
Fish Creek
Spark 4
Alpine West
Alpine
Lookout
Nanuk
Scout
Kokoda 5
Kokoda 1
Mitre
Spark-Rendezvous
Pioneer
Hunter
Contours are structure at approximate top of Alpine sandstone (feet below sea level)
70°N
Results outside of accumulations
Oil show
Gas show
Dry hole
Discovered accumulations in Alpine sandstone
Oil Gas
Announced:
Inferred:
Producing oil pools in Alpine field
Main reservoir
Alpine:
Other:

Figure 4—11. Oil and gas accumulations in or near the northeastern NPR-A
(Source: Houseknecht et al. 2010)

Projected development would include three-phase pipelines for oil development and two-phase pipelines for nonassociated gas development, vertical support members up to 40 miles in length, and gravel roads of equal length connecting the satellites to the Alpine facilities. The number of production, injector (oil production only), and disposal wells on each pad would depend on the discovered recoverable resource volume. ConocoPhillips, for example anticipates 29, 44, and 33 wells will ultimately be drilled on satellite pads CD-3, CD-4, and planned CD-5 (DeGeorge 2012). Barring unforeseen geotechnical difficulties, extended reach drilling, multi-lateral completions, and horizontal bores through the reservoir would be utilized to minimize surface disturbances in the NPR-A. Fracture stimulation would likely to be used to initiate or enhance commercial production. With the Alpine field and its current satellites in the decline phase of production there should be adequate capacity to add additional satellites from the NPR-A as they are developed.

Limited exploration drilling would likely occur within both exploratory units as obligation wells are required to be drilled (one well in the Bear Tooth Unit by early 2013 and two wells in the Greater Mooses Tooth Unit, one by 2015 and one by 2019) as required by exploratory unit agreements with the BLM. In the next 10 years, it is projected that several delineation/confirmation wells would be drilled to define the limits and productivity of these reservoirs before there is a commitment to full project development. Because of high development project costs, two to four successful delineation wells would be drilled to establish reservoir continuity and productivity.

At present, there are two exploratory wells drilled in the Lookout prospect. Current plans are to develop the Lookout discovery as Greater Mooses Tooth pad # 1 (GMT-1); formerly CD-6). This would begin after the first year of construction at CD-5 (Alpine West). It is likely to be no earlier than 2014 or 2015. Lookout is approximately 8 miles from where the CD-5 is proposed to be built. Current reserves estimates suggest it may have a single gravel pad with 11 producers and 10 injector wells. This includes a step-out well to the nearby Mitre prospect, which is assumed not to be developed from a dedicated gravel satellite pad. A pipeline from GMT-1 to the Alpine oil field would likely go through CD-5.

The Spark-Rendezvous accumulation is a much larger reservoir system of the five announced NPR-A discoveries (Spark-Rendezvous, Alpine West, Lookout, Mitre and Pioneer). There are now nine exploration/delineation wells drilled in this accumulation. The Rendezvous #2 and Altamura #1 wells are in the oil leg of a large prospect that is predominantly associated gas. Preliminary data from one well test suggest it may have reserves similar to those at CD-5. It would be developed from Greater Mooses Tooth Unit 2, a single 10-acre gravel pad with 17 producers and 16 injector wells. A development pad at about the center of this accumulation would be about 17 miles south of CD-5. However, its development may connect through Greater Mooses Tooth pad 1 by way of an 11-mile pipeline to and consequently share vertical support members or pipeline capacity through CD-5.

The Pioneer well tested an accumulation east of the Rendezvous #2 well. Test data suggest it is likely a condensate discovery. Its estimated reserves suggest it would be developed from a single pad with eight producers and seven injector wells. This prospect is about 15 miles south of CD-5. However, its development may find economic synergy by being connected with a pipeline to the Greater Mooses Tooth Unit 2, about 7 miles to the west.

The Scout accumulation would be developed as a nonassociated gas field. Its estimated reserves suggest it would be developed from a single central processing/compressor facility/pad with six producers and two water disposal wells. This accumulation would connect to the facilities at CD-5 via a 20-mile gas pipeline.

The Hunter accumulation would also be developed as a nonassociated gas field. Its estimated reserves suggest it would be developed from a single central processing/compressor facility/pad with three producers and one water disposal wells. This accumulation is about 24 miles southwest of CD-5. However, its development may connect to the gas pipeline at the Scout prospect, located about 8 miles to the northeast.

Table 4-7 on page 54 shows the estimated area of surface disturbance and amount of gravel required for projected satellite oil development facilities of these discoveries in the NPR-A.

Exploration seismic data acquisition would not occur as the majority of this area in northeast NPR-A has been covered by 3-D surveys. A basic assumption for this analysis is that exploration seismic surveys would not be repeated in areas for which survey data are already available. It is assumed to be less expensive to purchase data from the original contractor (or client) rather than conduct a new survey. Therefore, future exploratory seismic surveys with today's technology would likely be conducted in unsurveyed areas. That said, new and advanced seismic data surveys would likely be acquired over these producing fields within 10 to 20 years of initial production to enhance recovery of hydrocarbons. These reshoots could amount to two new 3-D surveys.

Although Alternative B-1 would make some of the lands within the Greater Mooses Tooth and Bear Tooth units unavailable for oil and gas leasing and would not allow non-subsistence permanent infrastructure, those provisions do not apply to the valid existing leases within the existing units. The no lease and no non-subsistence permanent infrastructure provisions would apply to any re-leasing of the tracts in the unit. However, for this analysis the BLM is assuming that leases within these units will remain valid and that further exploration and development of the units could occur regardless of the alternative adopted in the record of decision.

Table 4-7. Estimated area of surface disturbance and amount of gravel required for projected satellite development facilities of discoveries in the Greater Mooses Tooth and Bear Tooth units

Facility/disturbance	**Number of facilities/ miles/acres**	**Total amount of impact**
Satellite production pads (10 acres each)	5	50 acres
Wells	45 producers 33 injectors 3 water disposal	
Connecting roads to satellite fields (7.5 acres per mile)[1]	40 miles	300 acres
Vertical support members (150 per mile)[2]	24 miles	<1 acre
Two-phase gas pipeline (6.06 acres/mile)	28	170
Total acres		521 acres
Gravel consumption for basic development		
Central production facility (10,000 cubic yards per acre)	0 acres	0 cubic yards
Production pads (10,000 cubic yards per acre)	50 acres	500,000 cubic yards
Roads (41,000 cubic yards per mile)	24 miles	984,000 million cubic yards
Total gravel consumption		1.48 million cubic yards
Estimated borrow gravel pits[3]	1	104 acres

[1] Assumes there are eight miles between each satellite production pad.

[2] The number and distance between vertical support members varies as their use (http://www.alyeska-pipe.com/PipelineFacts/pipelineengineering.html)
Distance between:
- Anchor supports — 800 ft. to 1,800 ft.
- Standard supports — 60 ft. approx.

[3] Assumes one acre disturbed for a gravel pit to meet the gravel needs for five acres of gravel pad, road, airstrip, or other development.

2. Development of Discovered Oil near Umiat

Umiat is a discovered oil field located in the southeastern NPR-A. Twelve wells and a 3-D seismic survey delineate the extent of the majority of the accumulation. Umiat is a unique oil field with its relatively shallow depth (200 feet to 1400 feet), comparatively high API[2] gravity (36 degrees API), and its reservoir is partly within the permafrost. No other oil field like this exists. In addition, this field was discovered in 1946, and extensively tested (by NPR-A standards) and completely delineated by 1952. It has not produced commercial oil in the 65 years since its discovery. Consequently, the exact onset of production and the description of anticipated reservoir development is conjecture loosely based on other shallow oil fields. There are no modern public data from which to evaluate reservoir productivity.

Estimates of recoverable oil reserves vary between 70 million barrels (Molenaar 1982) to between 200 and 300 million barrels (Huckabay and Hanks 2009). For this analysis, the BLM is assuming that up to 150 million barrels of oil would be economical to produce from the discoveries near Umiat. Commercial gas is not considered likely to be developed at Umiat. However, the nearby Gubik gas field has been estimated to contain 600 billion cubic feet of recoverable gas, which may be used for cold gas injection as the preferred mechanism for pressure maintenance in producing Umiat oil. Despite the estimated volume of recoverable oil reserves, there are no submitted plans for development or unitization at Umiat. However, a current leaseholder has presented a possible development scenario for Umiat. Their analysis for possible oil field development is based on the reservoir interpretation of the 11 U.S. Navy wells (1946 to 1952) and the Husky Seabee well. The potential development consists of a central processing facility on a 10-acre pad, eight additional 3.5-acre pads for producer and injector wells, and 16 miles of connecting gravel roads (2 miles of road between each of the eight satellite pads). The entire footprint, including a sales pipeline either to the Coastal Plain in the area of the Meltwater field or to the Trans-Alaska Pipeline System at Pump Station 2, would be approximately 400 to 440 acres. The actual extent depends on the volume and areal distribution of recoverable reserves. The Umiat design differs considerably from single pad satellite developments on the Coastal Plain, where reservoirs are deeper, more highly pressured, associated with gas, and have higher oil temperatures. Table 4-8 shows estimated area of surface disturbance and amount of gravel required for possible oil development facilities of the known discovery near Umiat.

Delineation-well drilling would be coordinated with the results of 3-D seismic mapping. Exploration seismic data acquisition would not occur as the vast majority of the Umiat structure has been covered by a 3-D survey. One additional survey would likely be acquired over this structure within 10 to 20 years of initial production to enhance recovery of hydrocarbons.

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[2] API=American Petroleum Institute

Table 4-8. Estimated area of surface disturbance and amount of gravel required for a projected satellite oil development near Umiat

Facility/disturbance	Number of facilities/ miles/acres	Total amount of impact
Central production facilities (1 pad[1])	1	10 acres
Satellite production pads (3.5 acres each)[2]	8	28 acres
Wells	78 producers; 37 gas injector wells	
Connecting roads to satellite fields (7.5 acres per mile)	16 miles	120 acres
Infield vertical support members (VSMs;150 per mile)[3]	16 miles	<1 acre
Vertical support members to coastal plain or Trans-Alaska Pipeline System (81 per mile)[3]	80-92 miles	2-3 acres
Total acres		162 acres
Gravel consumption for basic development		
Central production facility (10,000 cubic yards per acre)	10 acres	100,000 cubic yards
8 production pads (10,000 cubic yards per acre)	28 acres	280,000 cubic yards
Roads (41,000 cubic yards per mile)	16 miles	656,000 cubic yards
Total gravel consumption		784,000 cubic yards
Estimated borrow gravel pits[4]	1	32 acres

1. Umiat has an active gravel airstrip.
2. Assumes that there are 2 miles between each satellite production pad.
3. The number and distance between vertical support members varies as their use (http://www.alyeska-pipe.com/PipelineFacts/pipelineengineering.html)
   Distance between:
   - Anchor supports - 800 ft. to 1,800 ft.
   - Standard supports - 60 ft. approx.
4. Assumes 1 acre disturbed for a gravel pit to meet the gravel needs for five acres of gravel pad, road, airstrip, or other development.

3. Development of Undiscovered Oil and Gas

Estimates of undiscovered resources are uncertain for geologic, engineering, and economic reasons. Geologic data are in a nearly constant state of revision, as new concepts are revealed by detailed studies, mapping, and new well information. Engineering evolves with new technology and experience. Economic conditions, such as oil and gas prices, are difficult to predict beyond the very near future. Nevertheless, estimates of oil and gas resources are necessary to provide the basis for identifying areas for possible future leasing and projecting reasonably foreseeable exploration and development scenarios for impact analysis.

This plan's impact analysis relies upon projections of the development of economically recoverable oil and gas. The BLM has based its projections of economically recoverable undiscovered oil and gas development on the work of other federal agencies. The USGS's *Economic Analysis of the 2010 U.S. Geological Survey Assessment of Undiscovered Oil and Gas in the National Petroleum Reserve in Alaska* (Attanasi and Freeman 2011) provides estimates of how much as yet undiscovered oil and gas resources could be economically produced from NPR-A and adjoining State marine waters. The USGS has also provided the BLM with tables that give analogous estimates for each of the eight economic zones into which the USGS partitioned the NPR-A for cost analysis.

The USGS's economic analysis is based on an oil and gas resource assessment for the NPR-A, including non-federal lands within its external boundaries and adjoining State of Alaska waters, completed in 2010. Using a geology-based assessment methodology, the agency estimated mean volumes of 896 million barrels of technically recoverable oil and about 53 trillion cubic feet of technically recoverable nonassociated natural gas in conventional, undiscovered accumulations within the NPR-A and adjacent State waters (Houseknecht et al. 2010). The assessment used the same 24 plays and methodology as identified in a 2002 USGS assessment. Quantitative assessments were revised for 11 of the 2002 assessment plays, 4 plays were eliminated due to recent drilling results, and 9 plays remained unchanged. The sum of undiscovered oil resources (896 million barrels of oil) plus liquids (oil and condensate) estimated to have been discovered during 2000–2010 (120 to 200 million barrels of oil) is only about 10 percent of the total undiscovered oil estimated by the 2002 assessment (10,560 million barrels of oil; table 1 in Houseknecht et al. 2010). This reduction reflects the results of exploration drilling, specifically an abrupt transition from oil to gas just 15–20 miles west of the Alpine oil field and poor reservoir quality in key formations (Houseknecht et al. 2010).

The USGS report's sum of undiscovered nonassociated gas resources (52.839 trillion cubic feet) plus gas resources estimated to have been discovered during 2000–2010 (1.9 to 3.0 trillion cubic feet) is approximately 90 percent of the total undiscovered nonassociated gas estimated by the 2002 assessment (61.352 trillion cubic feet). This slight reduction mostly reflects (1) the elimination of four gas-prone plays from quantitative assessment as conventional resources, (2) a substantial shift of resources from oil to gas in Beaufortian stratigraphic plays, and (3) a moderate shift of resources from oil to gas in Brookian stratigraphic plays (Houseknecht et al. 2010).

After estimating the amount of technically recoverable oil and gas, the USGS modeled the volumes of oil and gas, from undiscovered accumulations in the NPR-A, available as a function of specified market prices that offset costs of finding, developing, producing, and transporting the oil and gas to market. For this analysis, the BLM has reduced the amount of these resources and the number of economic accumulations in economic zones 110, 120, and 130 in proportion to the amount of the subsurface of those areas not within federal management and, therefore, not subject to the decisions of this plan. These areas include State offshore waters and Arctic Slope Regional Corporation and North Slope Borough subsurface acres that were included in USGS's analysis.

The BLM has relied principally on the price projections furnished by the Energy Information Administration (USDOI Energy Information Administration 2012) to choose appropriate prices for oil and gas to use in conjunction with the USGS's economic analysis. The Energy Information Administration projects prices to 2035 based upon different assumptions. Their highest price projections for oil and gas are those for the year 2035.

Table 4-9 illustrates prices resulting from some of these assumptions, including those that result in the lowest and highest prices. The Energy Information Administration describes the low oil price case as the result of assuming that there is significant improved access to resources, a willingness of OPEC (Organization of the Petroleum Exporting Countries) members to reduce price as a means to increase their market share, and low economic growth. In their high oil price case, they assume greater gross domestic product growth and more constrained supplies. The Energy Information Administration provided projections of gas prices based on low and high economic growth and on high and low estimated ultimate recovery of gas.

Table 4-9. Oil and gas price projections for 2035 (2010 dollars)

Oil (price per barrel)*		
Reference price $145	Low economic growth assumption $143	High economic growth assumption $148
	Low oil price $62	High Oil Price $200
Gas (price per thousand cubic feet)*		
Reference price $7.55	Low economic growth assumption $6.77	High economic growth assumption $7.77
	High estimated ultimate recovery $6.14	Low estimated ultimate recovery $8.47

* Prices for oil are rounded to the nearest dollar. Oil prices are for low-sulfur, light crude delivered to Cushing, Oklahoma. Gas prices are for gas delivered to the Henry Hub. (Source: USDOI Energy Information Administration 2012. Gas prices are converted from prices per million Btu to price per thousand of cubic feet by multiplying the price per million Btu by 1.025. (See the Energy Information Administration's Frequently Asked Questions at http://205.254.135.7/tools/faqs/faq.cfm?id-45&t=8)

Based upon the Energy Information Administration's projections, the BLM has determined to base its analysis of economically recoverable oil and gas from the NPR-A on the USGS's projections for $180 per barrel of oil and $8.67 per thousand cubic feet of gas. (The oil price is the closest to the EIA's estimate of future oil prices for which the USGS provides estimates of economically recoverable oil. Similarly, the gas price is the closest price to meet or exceed the EIA's estimate for which the USGS provides estimates of economically recoverable gas.) At these prices, according to Tables 3 and 4 of the USGS report, approximately 67 percent of technically recoverable oil (604 million barrels) and 31 percent of technically recoverable non-associated gas (16.45 trillion cubic feet) would be economic to produce (all projections are from the USGS's 20-year delay mean estimate). The oil price adopted for this analysis is the highest price analyzed by the USGS and roughly 38 percent greater than the reference price estimate to 2035 by the Energy Information Administration. The gas price is the highest estimated by the Energy Information Administration and is 12 percent higher than its reference price.

While it is theoretically possible that the USGS would have found more oil to be economically recoverable had it extended its analysis to a price of $200 per barrel, it is unlikely that substantially more oil would be able to be produced or that any such greater production would create substantially different infrastructure projections. The USGS's report (Table 4) does not project any increase in oil production between $162 and $180 per barrel, and production from all lands analyzed by the USGS rises only from 592 million barrels to 604 million barrels (i.e., 2 percent) between $150 and $180 per barrel. The USGS's analysis reflects smaller increases in production as prices rise.

There are good arguments to be made that the BLM should not adopt the highest gas price estimated by the Energy Information Administration or the closest USGS price to the Energy Information Administration's high oil price. The BLM is adopting these high estimates because it does not want to underestimate the potential development that may occur as an indirect result of its decision to offer oil and gas leases in the NPR-A. The public policymakers should be aware of the possible—though not probable—oil and gas production that could occur and its potential resultant impact to the physical, biological, and human environment. Two other factors argue the prudence of adopting the higher estimates. First, are the volatility of energy prices and the estimates of those prices. Short-term spikes shot prices to over $147 per barrel in July 2008. (The average price for the year, however, was $87.11.) The Energy Information Administration's projections have reflected the uncertainty in the energy market; its 2008 annual energy outlook projected oil prices of $70 barrel in 2030, while the 2012 report estimates a reference price that year of over $145. Second, erring on the high side is prudent to account for the long-term ramifications of the decisions that could result from this plan. The plan could be the basis for leasing for many years and leases offered as a result of the record of decision for this plan could produce oil and gas and potentially impact the environment for many years after 2035. No federal agency produces price projections beyond 2035—to do so is problematic, but adopting the higher price estimates allows the plan to compensate for the lack of longer-term projections.

The BLM believes that the oil and gas prices they are adopting will avoid underestimation of oil and gas production, activities, or potential impacts. Adopting the Energy Information Administration's high price estimates is part of the justification for such confidence. Realistically, industry, which must invest extremely large sums to produce oil and gas, understandably bases its investment on conservative price projections, so industry activity levels are likely to be lower than estimated in the present analysis. Some conventionally recoverable oil and gas may be located in pockets so small that they may never be discovered. Some oil and gas may be discovered and be conventionally recoverable, but only at extremely high prices. Finally, given oil and gas's central role in the world and national economies, increases in prices inevitably lead to higher prices for the equipment and supplies needed to extract it and the workers required to design, maintain, and operate infrastructure. These increased costs would make it increasingly difficult for industry to produce more oil and gas. At very high oil and gas prices the economically recoverable resource curve is nearly vertical and will only move toward the conventionally recoverable endowment at infinitely high (and therefore unrealistic) prices. Thus, the scenarios that we present below based on the Energy Information Administration's high oil and gas prices, given the relative inelasticity of economically recoverable petroleum at high prices, remain adequate for impact analysis even if prices, or, more relevantly, industry's assessment of long-term prices used in their investment strategies, were assumed to rise to or considerably upwards of the Energy Information Administration's projections used in this IAP/EIS.

The USGS's 2012 report's projections of 604 million barrels of economically recoverable oil and 16.45 trillion cubic feet of economically recoverable gas at oil prices of

$180/barrel and gas prices of $8.67 per thousand cubic feet, respectively, included some oil and gas from non-federal subsurface in economic zones 110, 120, and 130. The BLM has assumed that the oil and gas in the economic zones was distributed evenly within each zone, and consequently reduced the amount of oil and gas assumed to be economic to develop in federal subsurface in the northern economic zones proportionate to the amount of non-federal lands in the three zones. Thus, the economically recoverable oil in federal subsurface in NPR-A is assumed to be 491 million barrels and the economically recoverable gas in federal subsurface is assumed to be 15.891 trillion cubic feet (Figure 4—12).

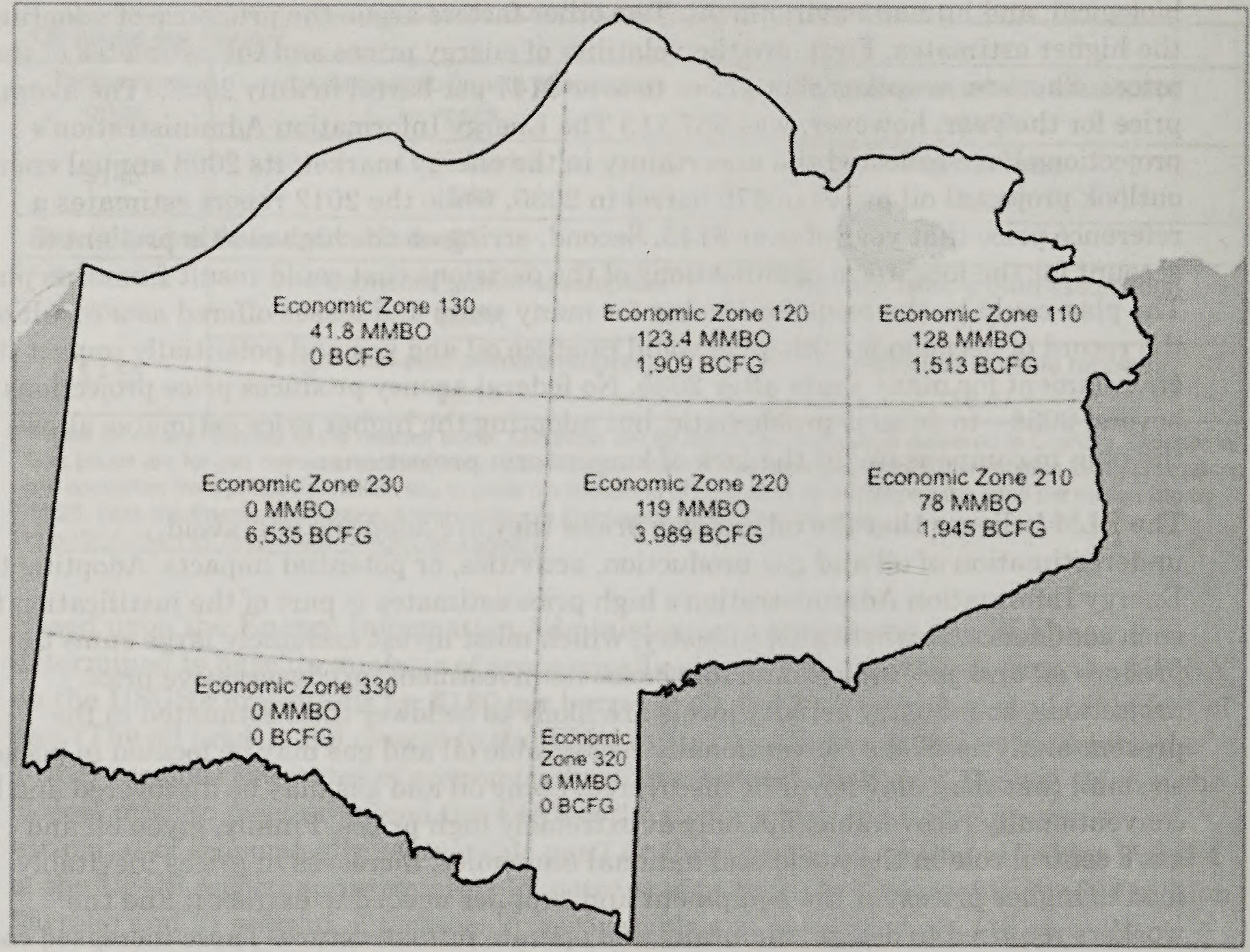
Economic Zone 130
41.8 MMBO
0 BCFG
Economic Zone 120
123.4 MMBO
1,909 BCFG
Economic Zone 110
128 MMBO
1,513 BCFG
Economic Zone 230
0 MMBO
6,535 BCFG
Economic Zone 220
119 MMBO
3,989 BCFG
Economic Zone 210
78 MMBO
1,945 BCFG
Economic Zone 330
0 MMBO
0 BCFG
Economic Zone 320
0 MMBO
0 BCFG

Figure 4—12. Federal subsurface economically recoverable undiscovered oil (at $180/barrel) and gas (at $8.67/thousand cubic feet) by USGS economic zone
(MMBO = million barrels of oil; BCFG = billion cubic feet of gas)

Two additional reductions in the estimate of economically recoverable oil and nonassociated gas are made for the alternatives. The first set of reductions is related to areas unavailable for leasing. Because the exact locations of commercial fields are unknown within the respective economic zone, it is assumed that the petroleum endowment is distributed evenly over the geographic extent of the economic zone. Admittedly, this is a simplistic assumption because commercial fields would occur in localized accumulations. However, prior to extensive drilling, the opportunity to discover new fields is relatively uniform throughout each of the geologic plays assessed by the USGS in assigning estimated resources for the economic zones. The fraction of the petroleum resource available for leasing and possible future development is determined as the available portion of each economic zone in the planning area. For instance, the estimated undiscovered federal oil resource for economic zone 110 is 128 million barrels. By scaling from economic zone maps, it was determined that 78.4 percent of the economic zone would not be offered for leasing under Alternative B-1. Multiplying this fraction by the total economic zone resource indicates that 100.4 million barrels would not be available and consequently would not contribute to future production under this alternative.

Under certain alternatives, the volume reduction of oil or gas affected accumulations with too few resources. Though deemed economic by statistical analysis, it is assumed that industry would deem these accumulations uneconomic to develop. As a result, the affected accumulations and their associated volumes of oil or gas were eliminated, further reducing the total volume of oil or gas in the affected alternative. For example, acreage made unavailable to leasing in economic zone 110 under Alternative B-1 resulted in a 78.4 percent reduction in the oil volume, assuming the oil was distributed evenly across the economic zone. This reduction leaves 27.6 million barrels of oil distributed among the five original oil accumulations (of varying size classes) in the economic zone. The number of accumulations in each size class is multiplied by the 78 percent reduction to determine how many accumulations would have at least a 50 percent probability or remaining. For example, of the three original accumulations in the size class of 16-32 million barrels of oil, only one accumulation survived after applying the test (3 accumulations x 0.78 = 2.36 accumulations eliminated; 3 accumulations – 2.36 eliminated accumulations = 0.64 percent probability that one accumulation (with 3.3 million barrels of oil) survived. Two other accumulations in the 32-64 million barrels of oil size class were similarly eliminated. As a result, four of the five accumulations failed the probability test and their associated volumes of oil (24.3 million barrels of oil) were eliminated.

A second set of reductions is also objective, as it is based on areas affected by restricted surface occupancy restrictions in setbacks (or buffers) that provide protection for sensitive localities. Restricted surface occupancy restrictions, which prohibit oil and gas production pads, could reduce industry interest in leasing, add costs to operations, or present difficult engineering challenges. Reductions for production estimates are valid even if the area underneath the buffer and enclosed area is technically reachable by directional drilling. In most cases, surface restrictions that would require directional drilling beyond 3 miles would cause economic burdens that could result in bypassed resource recovery or the elimination of marginal projects. Consequently, projections of oil recovery reflect a reduction equal to the estimated oil in lands with a restricted surface occupancy restriction more than three miles from areas without restricted surface occupancy restrictions.

Constraints other than surface occupancy restrictions, such as those contained in the required operating procedures/best management practices and the non-restricted surface occupancy stipulations of this plan, also could reduce the amount of oil or nonassociated gas recovered from the planning area. Additional volume reductions in oil and gas production may be the result of permitting requirements by federal, State, and local agencies regulators. The BLM has assessed that the technical impediments and economic costs of these less-than-restricted surface occupancy restrictions presented in this IAP/EIS would be roughly the same for each alternative for the lands that would be made available for leasing. At lower oil and gas prices, these impediments and costs may dissuade industry from pursuing some petroleum prospects or cause industry to develop the prospects more cautiously and slowly than at higher prices. For this impact analysis, however, we are projecting very high oil and gas prices. Under these circumstances, the BLM assumes for analysis that the economic return industry would receive on oil or gas development would justify overcoming the technical impediments and economic costs inherent in federal, State, and local government regulations other than those imposed by large restricted surface occupancy areas and areas not available for leasing.

Using these general concepts and reduction factors, resource estimates are defined for each of the alternatives. The specific reduction factors are identified by abbreviations: areas unavailable for leasing and restricted surface occupancy buffers. The BLM also provides production rates for undiscovered oil and nonassociated gas. For analysis purposes, the BLM assumes that for each alternative reserve volumes would be progressively developed to maximize the production rate consistent with the maximum zone pipeline rate provided by the USGS (86 million barrels of oil per day and 3 billion cubic feet of gas per day). The BLM assumes that oil and gas production would begin in 2032 and that development would take 1 to 2 years to reach the maximum daily production rate. The BLM further assumes that for oil, this rate would be produced for 10 years, and then the maximum rate would decline at 12 percent per year, ultimately completing recovery in 25 years. The BLM assumes that the peak daily gas production rate would be produced for 12 years. This maximum rate would then decline at 24 percent per year, completing recovering of the gas in 22 years. It is, of course, likely that some oil production would occur earlier than 2032, especially from the eastern NPR-A, and that initiation of production of at least some oil and gas accumulations would occur after 2042 (for oil) or 2044 (for gas). However, to better ensure that this plan does not underestimate production in any given period, we have made the above assumptions. Table 4-10 summarizes the anticipated economically recoverable oil and gas resources for each of the alternatives and also provides an estimate of the potential peak production. Figure 4—13 through Figure 4—22 illustrate the level of oil and gas production over time for the five alternatives.

Table 4-10. Undiscovered conventional oil and gas economic resource estimates for each alternative*

Alternative	A	B	B-2	C	D
Oil (million barrels)[1]	453	235	279	437	491
Gas (trillion cubic feet)[1]	8.599	6.911	7.238	13.888	15.891
Peak Oil Production[2] (million barrels of oil per day)	74	38	46	72	80
Peak Gas Production[3] (billion cubic feet per day)	1.54	1.23	1.28	2.42	2.82
Number of Oil Accumulations[4]	15	8	10	15	15
Number of Gas Accumulations[5]	32	24	28	46	49

* These figures are based on a market price of $180 per barrel of oil and $8.67 per thousand cubic feet of gas and it is assumed that there is a 20-year delay for discovery of hydrocarbon accumulations and their production that would access a gas pipeline to market. As noted in the text of this section, these federal oil and gas volumes provide estimates for impact analysis purposes that make it very unlikely that this IAP/EIS will underestimate impacts.

1. Mean federal economic oil and gas volumes are reduced from original USGS mean economic oil volumes of 604 million barrels of oil /16.452 trillion cubic feet of gas (under the 20-year gas delay assumption) as reported in Attanasi and Freeman (2011; Table 4). The USGS analysis included non-federal mineral estates (i.e., State offshore oil and gas and Native regional corporation oil and gas) in economic zones 110, 120, and 130. An assumption was made that the oil and gas was distributed evenly within these economic zones when subtracting out the number on non-federal acres. The total acres attributable to the USGS 2011 analysis equal 24,239,196 acres. Total acres of non-federal oil and gas in the USGS analysis equal 1,492,317 acres. Total federal acres equals 22,746,879 acres or resulting in about a 6 percent reduction in acreage and, therefore, a 6 percent reduction volume of oil and gas from the original USGS published mean economic oil and gas volumes. An additional 2 percent reduction is applied after weighting for oil and gas volumes by economic zone, resulting in an 8 percent reduction. Two further reductions are applied to arrive at the oil and gas volumes reported in Table 4-9 above and are described in subsection 3 – Development of Undiscovered Oil and Gas on page 56.
2. Peak oil production based on regional pipeline maximum capacity by economic zone (Table A3-1 of Attanasi and Freeman 2011) and a decline rate of 12 percent per year. Assumes peak oil production is maintained for 10 years and also assumes oil development occurs in stages to maintain peak production.
3. Peak gas production is based on regional pipeline capacity by economic zone (Table A3-1 of Attanasi and Freeman 2011), the assumed maximum 3-billion-cubic-feet-per-day high-pressure line from Inigok to a future gas conditioning plant near Pump Station 1, and a decline rate of 24 percent per year. Assumes peak gas production is maintained for 12 years and also assumes gas development occurs in stages to maintain peak production.
4. Number of oil accumulations is modified from Table A2-3 of the 2011 USGS NPR-A economic assessment (Attanasi and Freeman 2011). Size class accumulations from Table A2-3 are rounded up (for accumulation fractions greater than 0.50) or rounded down (for accumulation fractions less than or equal to 0.50) to the next whole number. For example, in oil economic zone 110 the number of statistically assigned accumulations in size class 64-128 MMBO is 0.64. This value is rounded up to 1 since the fraction is greater than 0.50. In size class 32-64 MMBO, the 1.5 accumulations is rounded down to 1 because the accumulation fraction is less than or equal to 0.50. Additional accumulation reductions were Alternative dependent and based on acreage reductions, which further reduced oil volume assigned to each economic zone.
5. Number of gas accumulations is modified from Table A2-3 of the 2011 USGS NPR-A economic assessment (Attanasi and Freeman 2011). Size class accumulations from Table A2-3 are rounded up (for accumulation fractions greater than 0.50) or rounded down (for accumulation fractions less than or equal to 0.50) to the next whole number. For example, in gas economic zone 110 the number of statistically assigned accumulations in size class 768–1,536 BCF is 0.38. This value is rounded down to 0 since the fraction is less than or equal to 0.50. Additional accumulation reductions were Alternative dependent and based on acreage reductions, which further reduced gas volume assigned to each economic zone.

Alternative A (No-action Alternative). The no-action alternative would continue to withhold approximately 9.46 million acres of the federal subsurface estate from leasing and development (Map 2-1). Approximately 58 percent of the federal subsurface estate in the NPR-A would be available for leasing. Specific reductions for this alternative are estimated at 41 percent unavailable for leasing, and 0.2 percent restricted surface occupancy. Under this alternative, economic oil volume is estimated at 453 million barrels of oil and economic nonassociated gas volume is estimated at 8.599 trillion cubic feet.

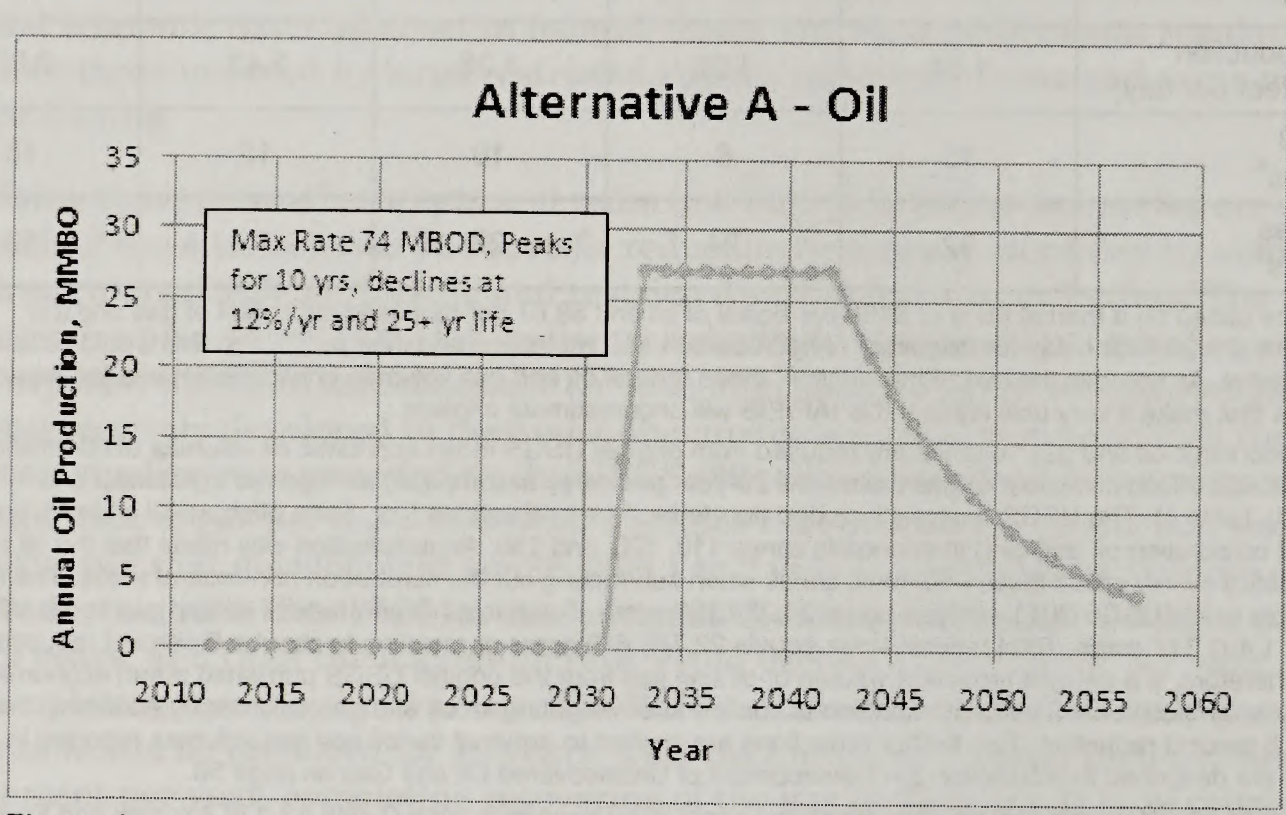

Figure 4—13. Assumed annual undiscovered oil production rate – Alternative A

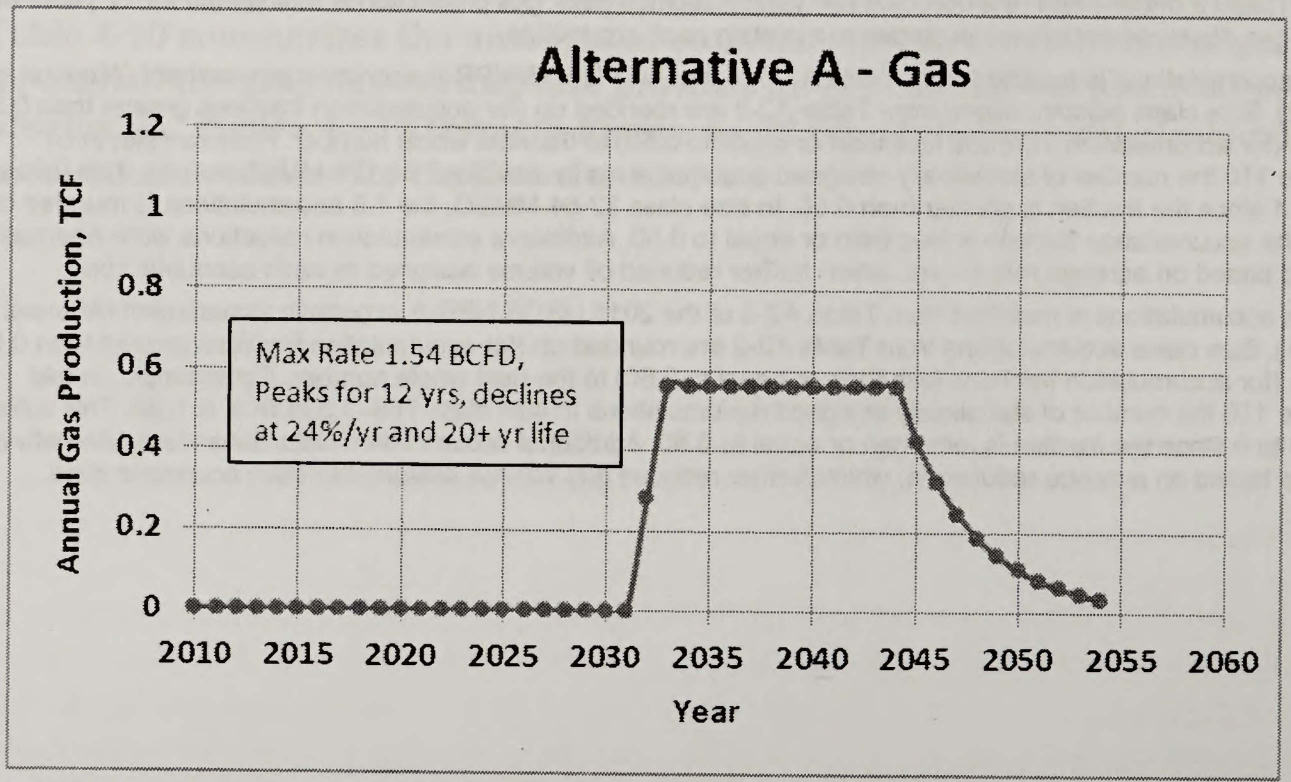

Figure 4—14. Assumed annual undiscovered nonassociated gas production rate in Alternative A

Alternative B-1. Under Alternative B-1, 48.9 percent of the federal subsurface estate within the planning area would be offered for leasing. Approximately 11.61 million acres would not be available for leasing (Map 2-2). The specific reductions are 51.1 percent unavailable for leasing and 0 percent restricted surface occupancy. Under this alternative, oil production is estimated at 235 million barrels of oil and economic nonassociated gas volume is estimated at 6.911 trillion cubic feet.

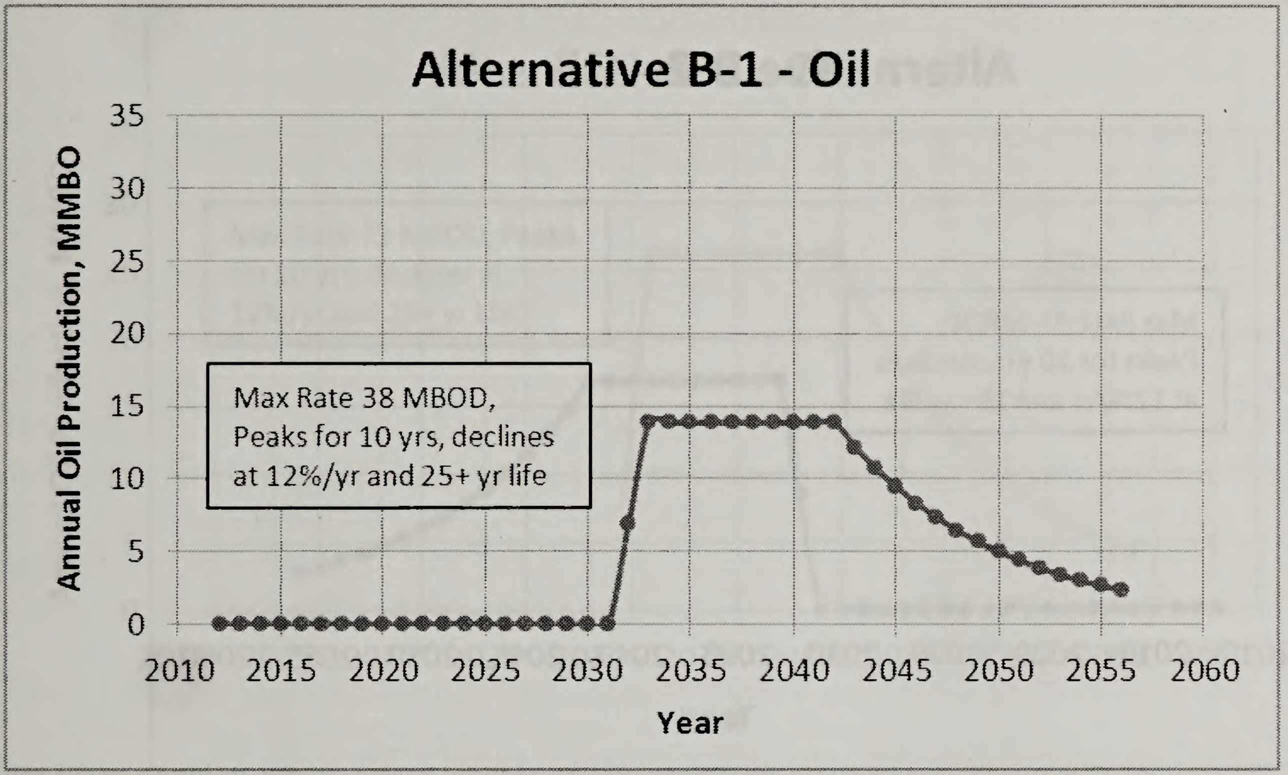

Figure 4—15. Assumed annual undiscovered oil production rate for Alternative B-1

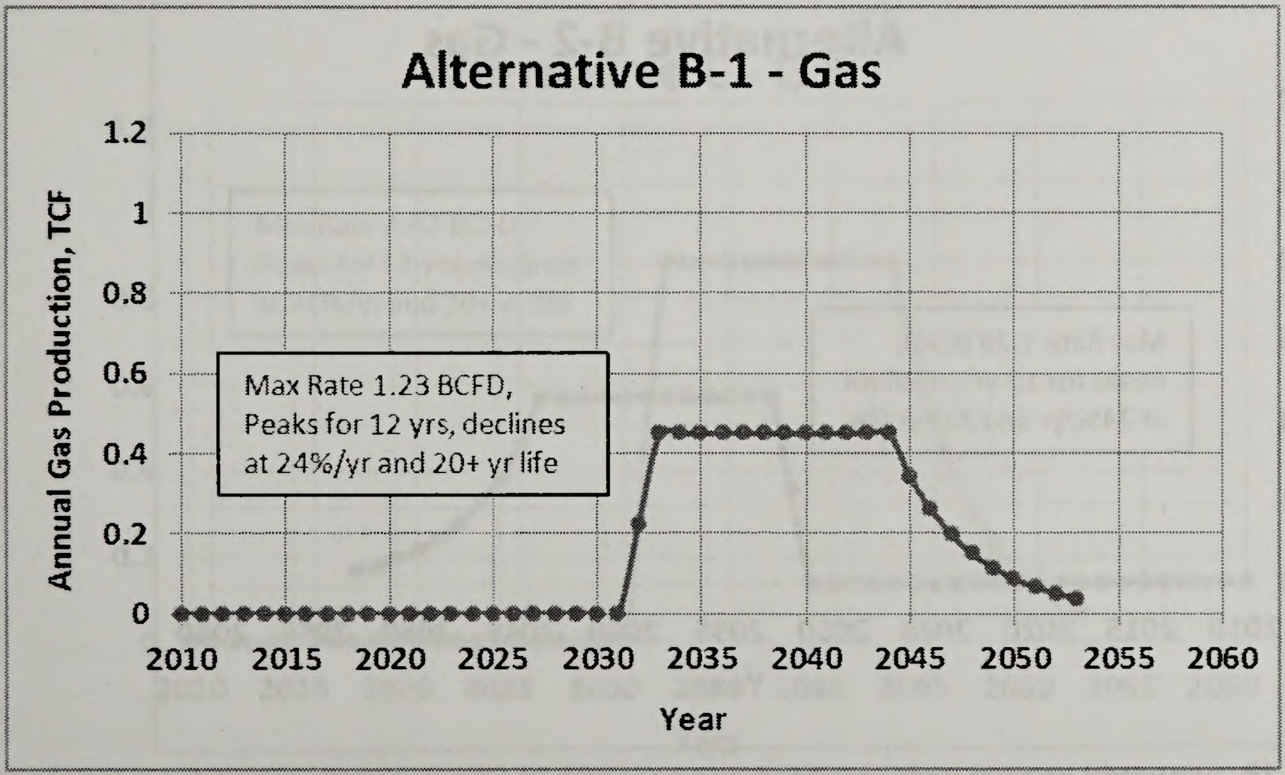

Figure 4—16. Assumed annual undiscovered nonassociated gas production rate for Alternative B-1

Alternative B-2. Under Alternative B-2, 51.8 percent of the federal subsurface estate within the planning area would be offered for leasing. Approximately 10.96 million acres would not be available for leasing (Map 2-2). The specific reductions are 48.2 percent unavailable for leasing and 0 percent restricted surface occupancy. Under this alternative, oil production is estimated at 279 million barrels of oil and economic nonassociated gas volume is estimated at 7.238 trillion cubic feet.

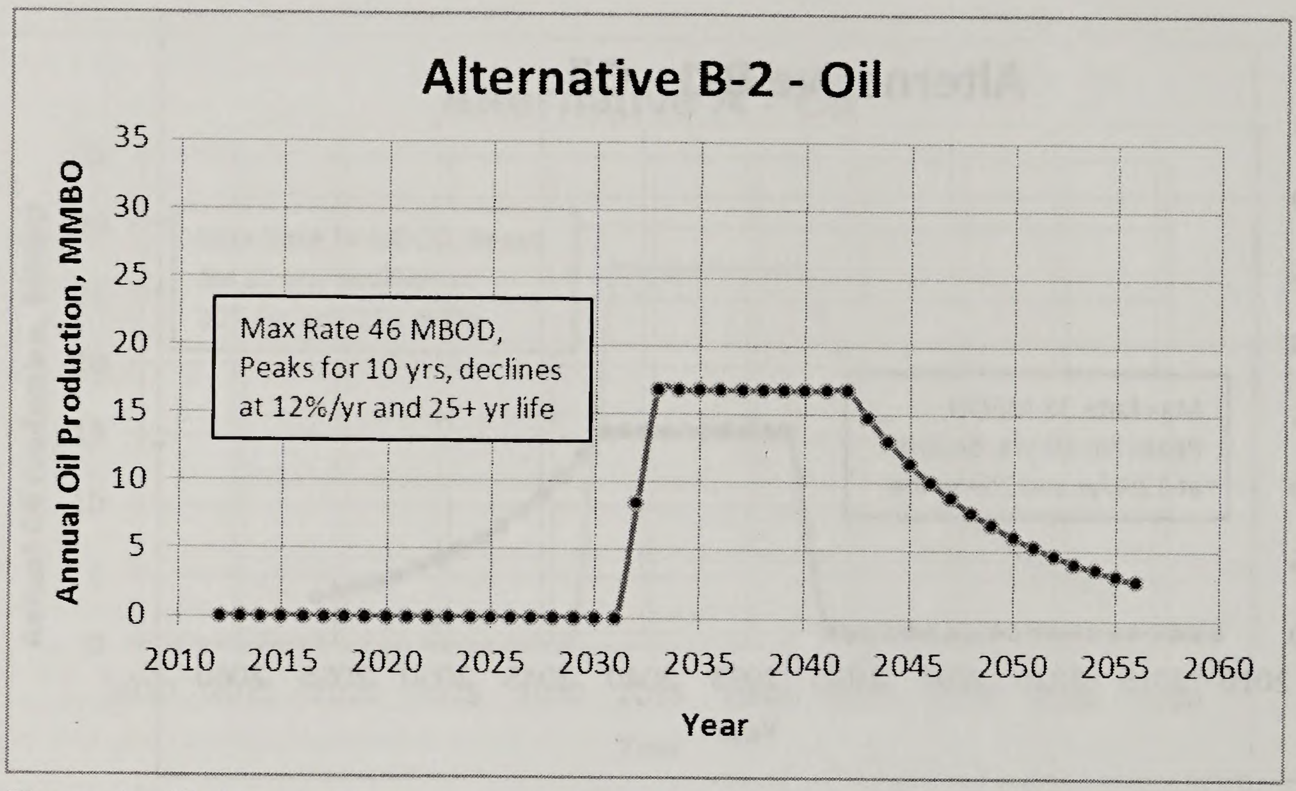

Figure 4—17. Assumed annual undiscovered oil production rate for Alternative B-2

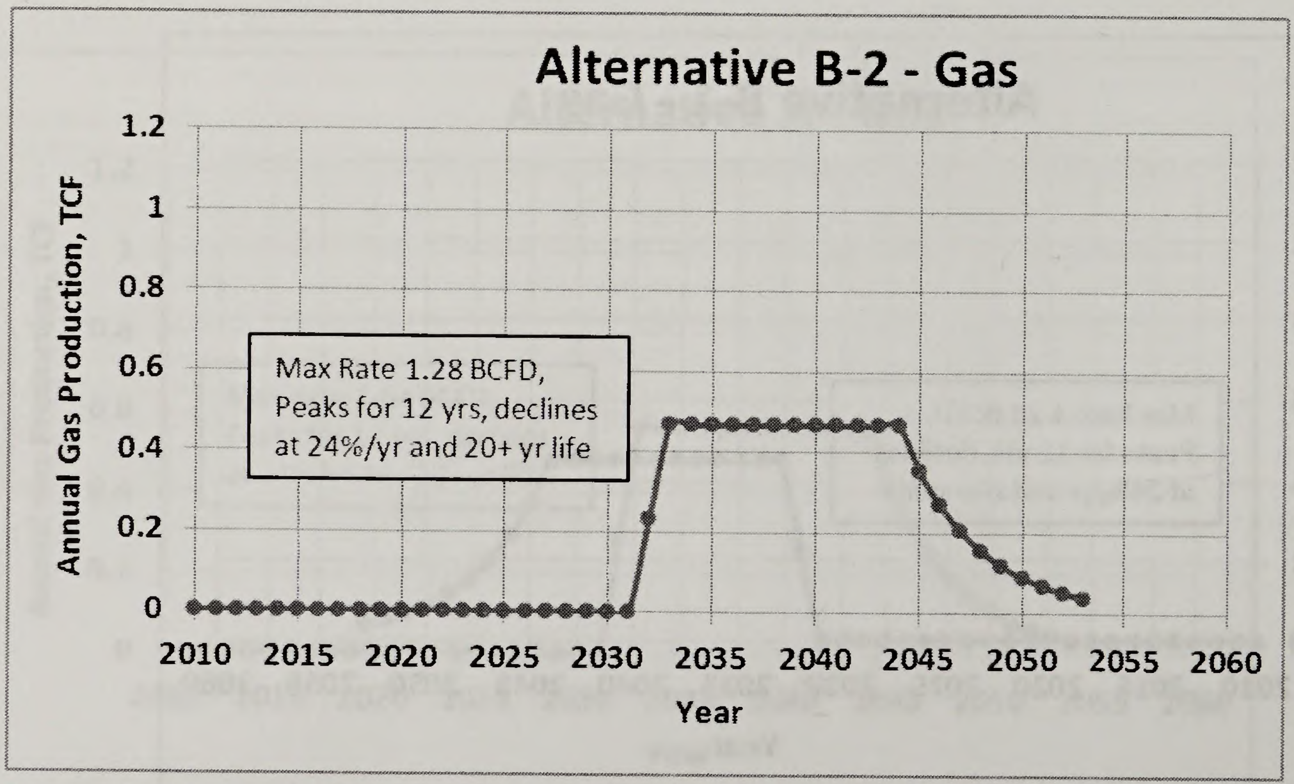

Figure 4—18. Assumed annual undiscovered nonassociated gas production rate for Alternative B-2

Alternative C. Under Alternative C, 75.5 percent of the federal subsurface estate within the planning area would be offered for leasing. Approximately 5.57 million acres would not be available for leasing (Map 2-3). The specific reductions are 23 percent unavailable for leasing and 2 percent restricted surface occupancy. Under this alternative, oil production is estimated at 437 million barrels and economic nonassociated gas volume is estimated at 13.888 trillion cubic feet.

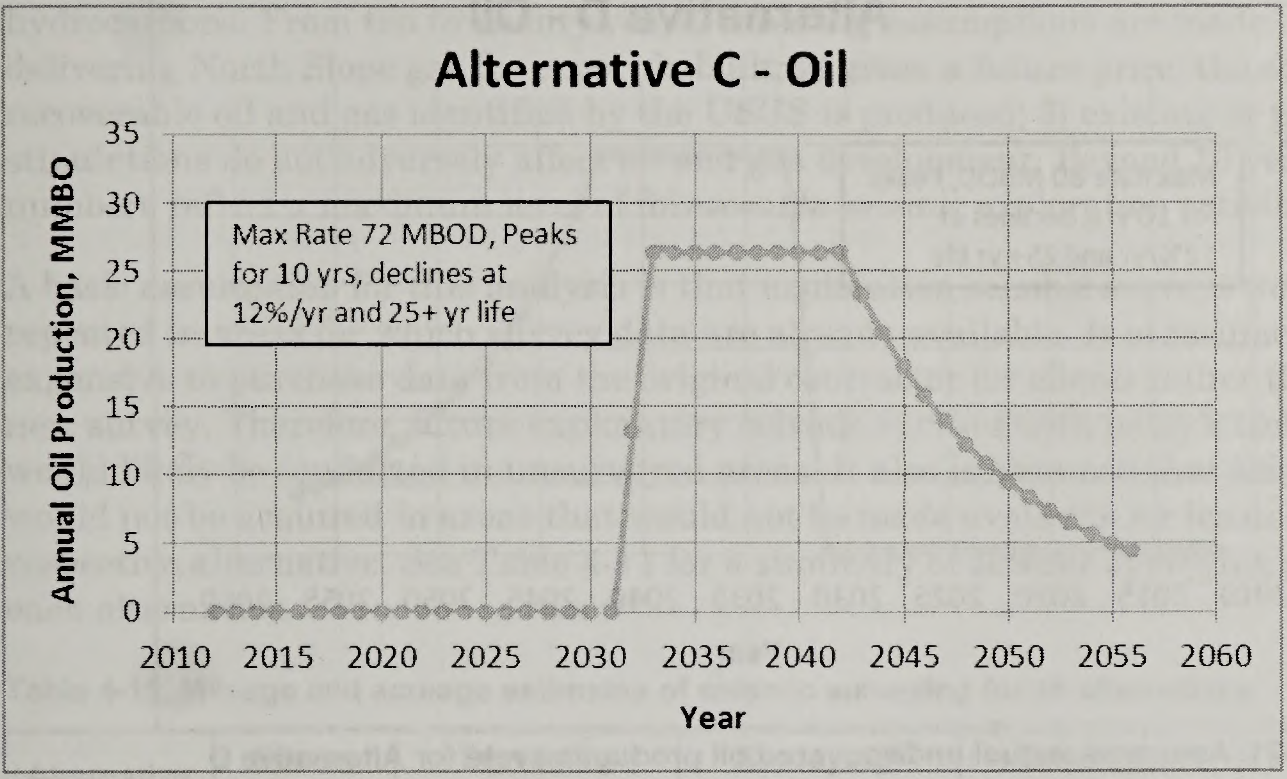

Figure 4—19. Assumed annual undiscovered oil production rate for Alternative C

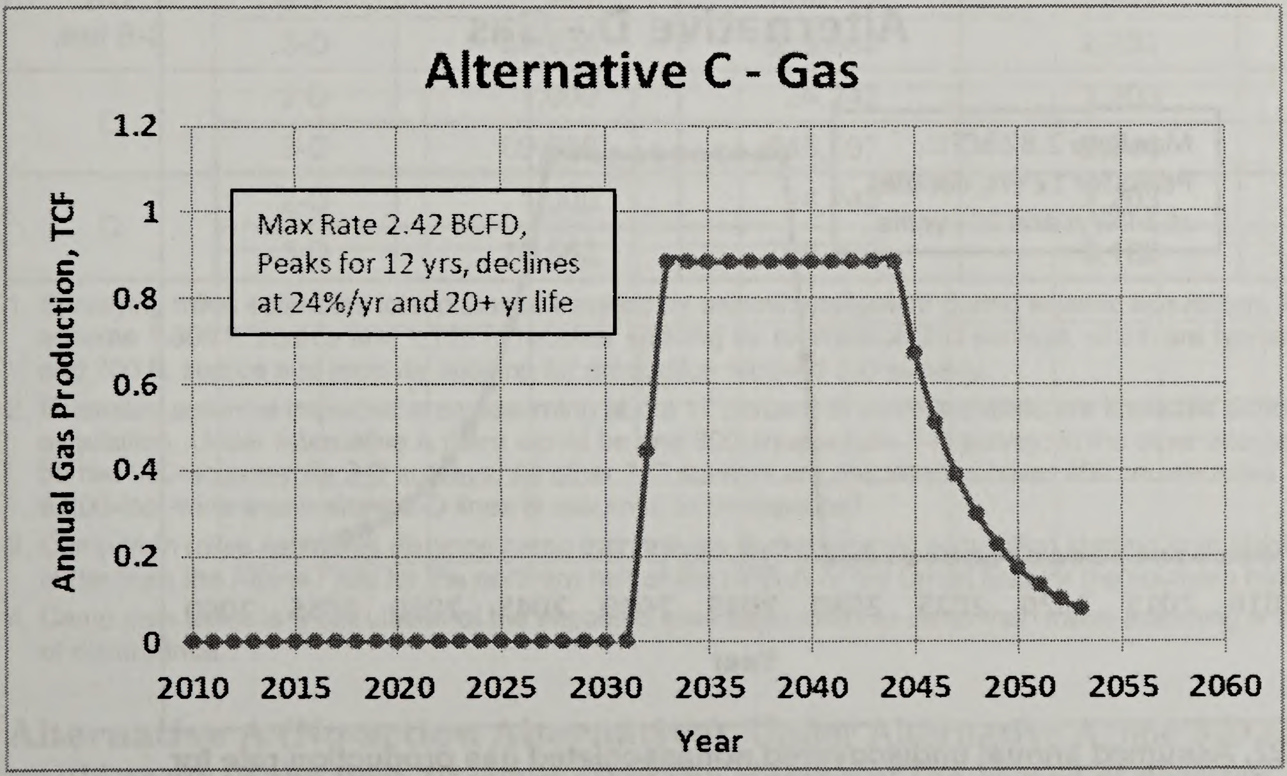

Figure 4—20. Assumed annual undiscovered nonassociated gas production rate for Alternative C

Alternative D. Under Alternative D, the entire federal subsurface estate within the planning area would be available to leasing (Map 2-4). There would not be any specific reductions in areas unavailable for leasing or restricted surface occupancy. Under this alternative, economic oil volume is estimated at 491 million barrels of oil and economic nonassociated gas volume is estimated at 15.891 trillion cubic feet.

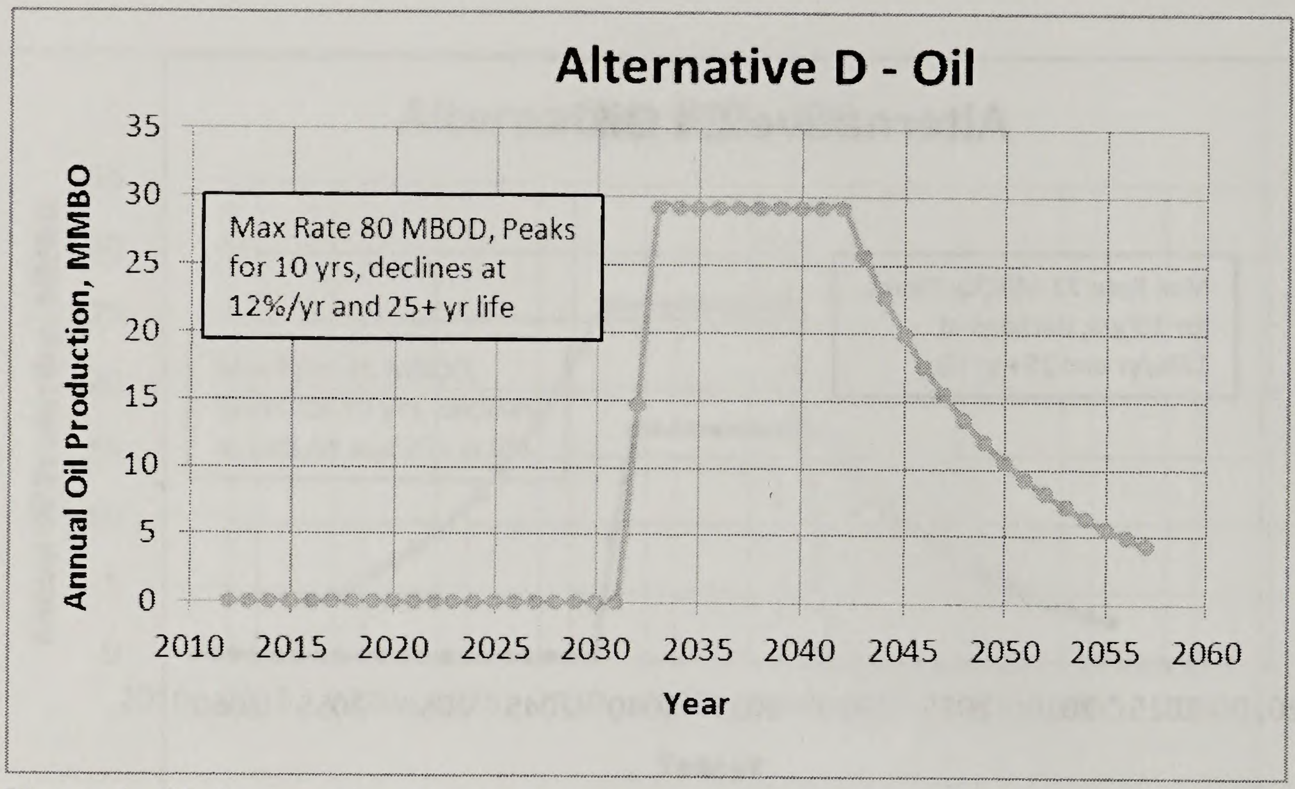

Figure 4—21. Assumed annual undiscovered oil production rate for Alternative D

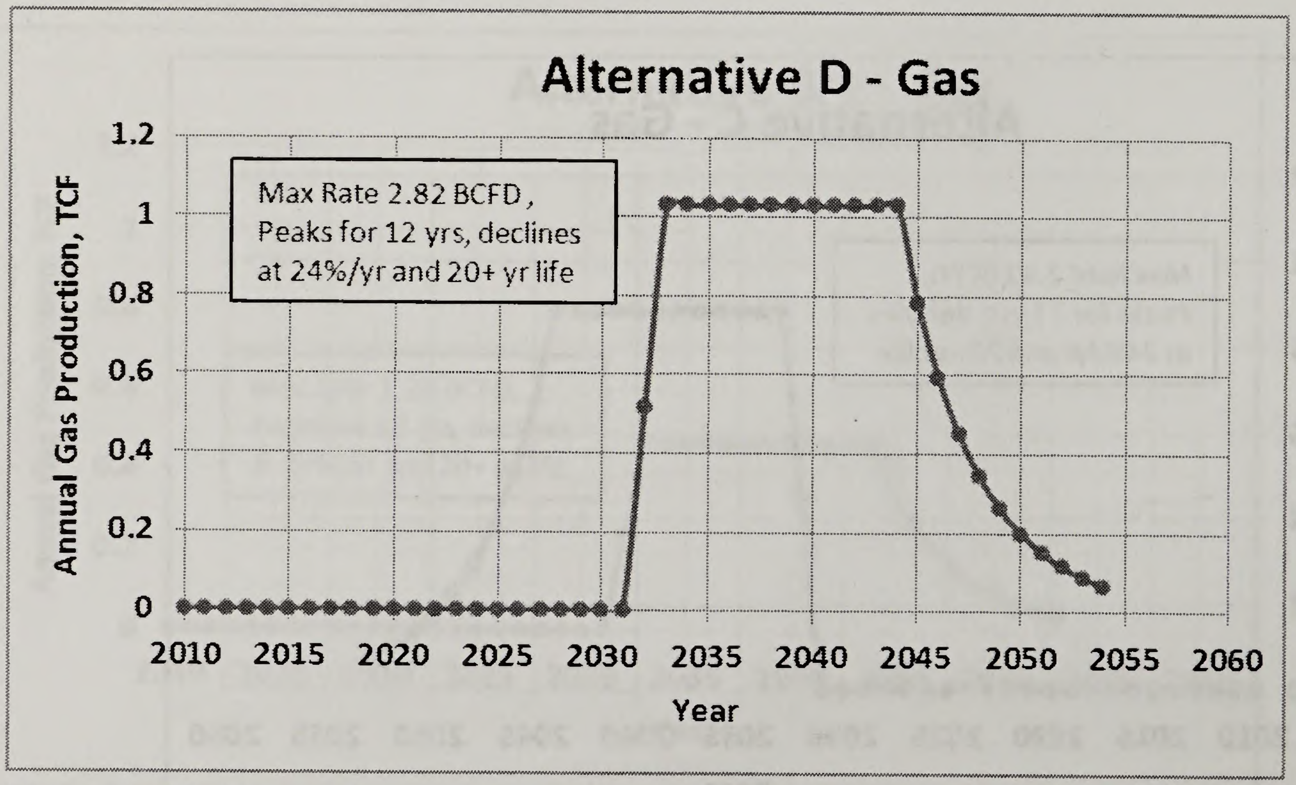

Figure 4—22. Assumed annual undiscovered nonassociated gas production rate for Alternative D

Projected Seismic Activity by Alternative

The level of future seismic activity in the NPR-A will depend on: 1) new oil discoveries and emerging play fairways; 2) production and development; 3) regulatory restrictions on activities. It is reasonably foreseeable that one to two new geologic play trends will be explored in the NPR-A in the next 20 years. It is also reasonably foreseeable that Greater Mooses Tooth and Bear Tooth units and/or the Umiat Field will begin development. New and advanced seismic data surveys would likely be acquired over these producing fields within 10 to 20 years of production to enhance recovery of hydrocarbons. From ten to twenty years, three big assumptions are made: 1) a gas line delivering North Slope gas for export is built; 2) given a future price, the economically recoverable oil and gas identified by the USGS is produced; 3) existing or planned stipulations do not adversely affect oil and gas development. Beyond 10 years, these numbers reflect a maximum level of foreseeable seismic exploration activity.

A basic assumption for this analysis is that exploration seismic surveys would not be repeated in areas for which survey data are already available. It is assumed to be less expensive to purchase data from the original contractor (or client) rather than conduct a new survey. Therefore, future exploratory seismic surveys with today's technology would likely be conducted in unsurveyed areas. It also is assumed that seismic data would not be acquired in areas that would not be made available for leasing in the respective alternative. See Table 4-11 for a summary of seismic surveying potential in each alternative.

Table 4-11. Mileage and acreage estimates of seismic surveying for all alternatives

Alternative	Survey Type	Surveying miles[1]	Surveying[2] acres	Camp Train miles[3]	Camp Train acres[4]
A	2-D	500	12,121	523	6,339
	3-D	53,678	496,125	1,936	23,467
B-1 and B-2	2-D	500	12,121	523	6,339
	3-D	57,838	535,882	2,232	27,055
C	2-D	1,000	24,242	1,203	14,582
	3-D	69,906	645,597	2,844	34,473
D	2-D	1,000	24,242	1,203	14,582
	3-D	76,562	709,209	3,182	38,570

1. Surveying miles estimates total distance traveled by seismic equipment during seismic acquisition. These estimates assume 1,500 ft. source and 1,100 ft. receiver spacing for exploration 3-D surveys, which are typical for the NPR-A, and 700 ft. source and receiver spacing for production focused 3-D surveys.
2. Estimates potential impacted area assuming about 17 percent of surveyed lands are impacted during 3-D seismic acquisition. Under Alternative A there would be one 900-square-mile 3-D survey; in the other alternatives there would be two 900-square-mile 3-D surveys. All other 3-D surveys are assumed to cover 400 square miles. For 2-D surveys, a 200-foot-wide swath along 2-D lines is assumed to be impacted.
3. Camp train miles estimates distance camp train travels during seismic acquisition starting from staging area, which is either from the Alpine Field for the northern half of the NPR-A or the Umiat field for the southern half of the NPR-A.
4. Camp train acres is a calculation of the impacted area attributable to camp train travel assuming a 100-foot-wide area of disturbance.

Alternative A (No-action Alternative). Under Alternative A, one 3-D seismic survey would occur in the first 10 years after the signing of the record of decision. It is foreseeable that four seismic surveys—one 2-D (approximately 500 linear miles) and three 3-D—would occur in the following 10 years. It is assumed that exploration-focused

3-D surveys acquired in economic zone 130 would be 900 square miles. Oil fields in this area could be trapped in relatively small accumulations or clusters across a relatively large geographic area requiring larger 3-D volumes for identification of potential traps. Producing oil fields would likely have repeated 3-D seismic imaging to enhance recovery after 10 years of production (i.e., approximately 10 to 30 years from the record of decision). These reshoots would amount to four surveys. Gas discoveries in the Nanushuk fold and thrust belt would likely be developed with 3-D seismic resulting in two 3-D surveys. Therefore it is foreseeable that there would be up to 11 seismic surveys, 5 exploration-focused and 6 production-focused surveys, acquired in the NPR-A under the no-action alternative.

Alternatives B-1 and B-2. Under Alternatives B-1 and B-2, large areas are unavailable for leasing and drilling activities. One 3-D seismic survey would occur in the first 10 years after the signing of the record of decision. It is foreseeable that four seismic surveys—one 2-D (approximately 500 linear miles) and three 3-D—could occur in the following 10 years. It is assumed that exploration-focused 3-D surveys acquired in economic zone 130 would be 900 square miles. Oil fields in this area could be trapped in relatively small accumulations or clusters across a relatively large geographic area requiring larger 3-D volumes for identification of potential traps. Producing oil fields would likely have repeated 3-D seismic imaging to enhance recovery after 10 years of production (i.e., approximately 10 to 30 years from the record of decision). These reshoots would amount to three surveys. Alternatives B-1 and B-2 would have more seismic activity associated with gas production than Alternative A because 1,671 more square miles would be available for leasing in economic zones 230 and 220. Gas discoveries in the Nanushuk fold and thrust belt would likely be developed with 3-D seismic resulting in three 3-D surveys. Therefore, it is foreseeable that there would be up to 11 seismic surveys, 5 exploration-focused and 6 production-focused surveys acquired in the NPR-A under Alternatives B-1 and B-2.

Alternative C. All NPR-A lands would be available excluding about 4.4 million acres in the southwestern NPR-A, about 219,000 acres under Teshekpuk Lake and its islands, the existing Kasegaluk Lagoon Special Area, the proposed (smaller size) Peard Bay Special Area, and the major coastal waters of Elson Lagoon, Dease Inlet, and Admiralty Bay. One 3-D seismic survey would occur in the first 10 years after the signing of the record of decision. It is foreseeable that five seismic surveys - two 2-D (approximately 500 linear miles each) and three 3-D - could occur in the following 10 years. It is assumed that exploration-focused 3-D surveys acquired in economic zone 130 would be 900 square miles. Oil fields in this area could be trapped in relatively small accumulations or clusters across a relatively large geographic area requiring larger 3-D volumes for identification of potential traps. Producing oil fields would likely have repeated 3-D seismic imaging to enhance recovery after 10 years of production (i.e., approximately 10 to 30 years from the record of decision). These reshoots would amount to four surveys. Gas discoveries in the Nanushuk fold and thrust belt would likely be developed with 3-D seismic resulting in four 3-D surveys. Therefore it is foreseeable that there would be up to 14 seismic surveys, 6 exploration-focused and 8 production focused-surveys, acquired in the NPR-A under Alternative C.

Alternative D. All lands would be available. Under Alternative D, two 3-D seismic surveys would occur in the first 10 years after the signing of the record of decision. It is foreseeable that six seismic surveys - two 2-D (approximately 500 linear miles each) and four 3-D - could occur in the following 10 years. It is assumed that exploration focused 3-D surveys acquired in economic zone 130 would be 900 square miles. Oil fields in this area could be trapped in relatively small accumulations or clusters across a relatively large geographic area requiring larger 3-D volumes for identification of potential traps. Producing oil fields would likely have repeated 3-D seismic imaging to enhance recovery after 10 years of production (i.e., approximately 10 to 30 years from the record of decision). These reshoots would amount to four surveys. Gas discoveries in the Nanushuk fold and thrust belt would likely be developed with 3-D seismic resulting in four 3-D surveys. Therefore it is foreseeable that there would be up to 16 seismic surveys, 8 exploration-focused and 8 production-focused surveys, acquired in the NPR-A under Alternative D.

Estimated Drilling Rigs, Pad-based Wells, and Surface Disturbance Due to Undiscovered Oil and Gas Activity

Table 4-12 provides information by alternative on the number of drilling rigs that may be active in any given year for exploration and delineation well drilling and the number of production and service wells anticipated to develop the undiscovered resources projected to be produced. Production and service wells would be located on gravel pads. Table 4-13 provides estimates of the long-term and short-term acres impacted by oil exploration and development actions for each alternative. Short-term activities are commonly associated with the footprint during winter exploration or construction, while the long-term acreage figures reflect the gravel footprint of the development. These figures are most reflective of potential impacts to physical resources such as soil and vegetation; for many other resources, impacts are not as directly or proportionately tied to a footprint. For more information on assumptions and methodologies, see the notes below these tables.

Table 4-12. Estimated exploration/delineation drilling rigs and production and service wells for undiscovered oil and gas for each alternative*

Alternative	A	B-1	B-2	C	D
Oil exploration/delineation drilling rigs[1]	3	2	2	3	3
Gas exploration/delineation drilling rigs[1]	4	3	3	4	5
Oil production and service wells[2]	764	404	476	738	826
Gas production wells and water disposal wells[3]	291	220	229	423	488

*These figures provide realistic and conservative estimates for impact analysis purposes that make it very unlikely that this IAP/EIS will underestimate impacts.

1. Rig totals are the maximum number operating in any single year.
2. Number of oil production wells equals the federal economic oil volume for each size class divided by the given recovery for each production well. For example, under Alternative D, Economic Zone 110 has one 44 million barrel federal economic oil accumulation with an average well recovery of 1.2 million barrels of oil. Thus, 44 million barrels of oil / 1.2 million barrels of oil = 37 production wells. The average well recovery is taken from Table A3-2 of Attanasi and Freeman, 2011. Production to service well ratio is 1:1 as assumed by Attanasi and Freeman (2011). Note: the Alpine oil field ratio is 1:1.
3. Number of gas production wells equals the federal economic gas volume for each size class divided by the given recovery for each production well. For example, under Alternative D, Economic Zone 210 has one 624 BCF federal economic gas accumulation with a well recovery of 43.1 billion cubic feet. Thus 624 billion cubic feet /43.1 billion cubic feet per well = 14 production wells. The average well recovery is taken from Table A3-3 of Attanasi and Freeman (2011). The number of water disposal wells is derived by assuming 1.5 disposal wells for each gas compressor facility

Table 4-13. Estimated surface disturbance for undiscovered oil and gas-related activities under each alternative*

Facility	Alternative A			Alternative B-1			Alternative B-2 Preferred Alternative			Alternative C			Alternative D		
	No.	Disturbance (acres)		No.	Disturbance (acres)		No.	Disturbance (acres		No.	Disturbance (acres)		No.	Disturbance (acres)	
		Short term	Long term		Short term	Long term		Short term	Long term		Short term	Long term		Short term	Long term
Oil exploration wells[1] (6 acres each)	30	180	< 1	16	96	< 1	20	120	< 1	30	180	< 1	30	180	< 1
Gas exploration wells[1] (6 acres each)	68	408	< 1	48	288	< 1	56	336	< 1	92	552	< 1	98	588	< 1
Oil delineation wells[2] (6 acres each)	30	180	< 1	16	96	< 1	20	120	< 1	30	180	< 1	30	180	< 1
Gas delineation wells[2] (6 acres each)	68	408	< 1	48	288	< 1	56	336	< 1	92	552	< 1	98	588	< 1
Central processing facility (oil)[3] (40 acres each)	11	440	440	8	320	320	8	320	320	11	440	440	11	440	440
Gravel production pad (oil)[3] (10 acres each)	3	30	30	1	10	10	1	10	10	2	20	20	3	30	30
Gravel production pad/cpf/gas compressor facility (Nonassociated gas)[4] (10 acres each)	27	270	270	19	190	190	21	210	210	39	390	390	42	420	420
Gravel production pad (Nonassociated gas)[4] (6 acres each)	60	360	360	42	252	252	47	252	252	94	564	564	103	618	618

Table 4-13. Estimated surface disturbance for undiscovered oil and gas-related activities under each alternative*

Facility	Alternative A			Alternative B-1			Alternative B-2 Preferred Alternative			Alternative C			Alternative D		
	No.	Disturbance (acres)		No.	Disturbance (acres)		No.	Disturbance (acres		No.	Disturbance (acres)		No.	Disturbance (acres)	
		Short term	Long term		Short term	Long term		Short term	Long term		Short term	Long term		Short term	Long term
In-field gravel roads[5] (miles; 7.5 acres/mile)	645	4,838	4,838	440	3,300	3,300	510	3,825	3,825	915	6.863	6.863	990	7,425	7,425
Gravel runway[6] (11 acres each)	38	418	418	27	297	297	29	319	319	50	550	550	53	583	583
Three-phase produced fluids (oil, gas, water) gathering/feeder lines[7] (miles)	184	789	9	114	489	6	114	489	6	184	789	9	184	789	9
Regional oil pipelines[8] (miles)	502	2,142	14	359	1,532	10	359	2,142	14	502	2,142	14	502	2,142	14
Two-phase produced fluids (gas and NGLs) gathering/feeder lines[9] (miles)	504	3,055	916	424	2,570	771	529	3,055	916	1,593	9,654	2,893	1,638	9,927	2,978
Regional gas pipelines[10] (miles)	180	1,091	327	290	1,758	528	290	1,091	327	360	2,182	655	360	2,182	655
High pressure gas line from inigok[11] (miles)	50	303	91	50	303	91	50	303	91	50	303	91	50	303	91
Booster pump stations (oil)[12] (5 acres each)	2	10	10	2	10	10	2	10	10	2	10	10	2	10	10
Compressor stations (gas)[13] (5 acres each)	0	0	0	0	0	0	0	0	0	1	5	5	1	5	5
Staging bases[14] (50 acres each)	4	200	200	3	150	150	3	200	200	6	300	300	8	400	400

Table 4-13. Estimated surface disturbance for undiscovered oil and gas-related activities under each alternative*

Facility	Alternative A			Alternative B-1			Alternative B-2 Preferred Alternative			Alternative C			Alternative D		
	No.	Disturbance (acres)		No.	Disturbance (acres)		No.	Disturbance (acres		No.	Disturbance (acres)		No.	Disturbance (acres)	
		Short term	Long term		Short term	Long term		Short term	Long term		Short term	Long term		Short term	Long term
Gravel pits[15]	≤ 38	1,313	1,313	≤ 27	906	906	≤ 29	1,313	1,313	≤ 50	1,840	1,840	≤ 53	1,987	1,987
Ice road/snow-packed trails[16] (miles; 4.2 acres/mile)	77,240	324,408	0	55,237	231,995	0	59,342	324,408	0	102,689	431,294	0	108,734	456,683	0
Ice airstrips[17] (11 acres each)	100	1,100	0	65	715	0	65	1,100	0	125	1,375	0	120	1,320	0
Total acres		**341,943**	**9,236**		**245,565**	**6,841**		**341,943**	**9,236**		**460,647**	**14,647**		**486,800**	**15,665**

* These figures provide realistic estimates for impact analysis purposes that make it very unlikely that this IAP/EIS will underestimate impacts. For seismic survey potential disturbance area, see Table 4-11.

1. Assume two exploration wells for each of the projected oil accumulations and two exploration wells for each of the projected gas accumulations. Projected oil accumulations range from 8 to 15 and projected gas accumulations range from 24 to 49 depending on the alternative. Includes drilling of one exploration well in the Bear Tooth unit (by early 2013) and two exploration/delineation wells in the Greater Mooses Tooth unit (one by 2015 and one by 2019) as required by exploratory unit agreements with BLM. Long-term acreage disturbance totals an area approximate 8x8 feet for each well in which the well cellar is excavated and a very small additional area around the cellar that may experience thermal change. Exploratory drilling is conducted during the winter, which reduces impacts to surface resources.
2. Assume two delineation wells for each of the oil accumulations and two delineation wells for each of the gas accumulations. Projected oil accumulations range from 8 to 11 and projected gas accumulations range from 24 to49. All are Alternative dependent. See note 1 for a discussion of the long-term effect associated with well cellars.
3. The number of central processing facilities and satellite pads are a function of the number of economically viable accumulations in each alternative. For example, in Alternative D the number of central processing facilities is based on projections of 15 viable oil accumulations that would justify 8 stand-alone oil development facilities, each housing one CPF and producing from a single accumulation, and 3 joint oil development complexes, each housing a central processing facility/production pad (producing from an oil accumulation) and one satellite accumulation/production pad (producing from a second oil accumulation). Oil produced from the second accumulations would be piped and processed at the central processing facility/production pad. One additional oil accumulation has no onsite gravel production pad but is produced from wells located on an adjoining joint development central processing facility/production pad.
4. The total number of central processing/gas compressor facilities for the Alternative D example includes 42 stand-alone nonassociated gas development facilities, each housing one central processing/gas compressor facilities /production pad, and projections of 7 joint nonassociated gas development complexes, each housing a central processing/gas compressor facilities/production pad, two satellite accumulation, and 3 to 5 additional production pads. (35 stand-alone developments + 7 joint developments = 42 total central processing/gas compressor stations. The total gravel production pads without a central processing/gas compressor facilities = 103 based on accumulation size class. Total projected nonassociated gas accumulations = 49 (35 reached by stand-alone development facilities + (7 joint developments x 2 accumulations per joint development) = 49) in size classes ranging from 250 billion cubic feet to 3,072 billion cubic feet.
5. Assume 10 to 15 miles of gravel road per satellite oil production pad, 19-35 miles of gravel road for a joint gas development, and 4 to 20 miles of gravel road per stand-alone gas development. For example, Alternative D would involve 3 joint oil development complexes = 10 to 15 miles x 3 satellite production pads = 30 to 45 miles; 7 stand-alone oil complexes = 0 miles of satellite production pads; 7 joint gas developments = 19 to 35 miles/development x 7 = 133 to 245 miles; and 35 stand-alone gas developments = 4 to 20 miles/development x 35 = 140 to 700 miles. Total infield roads = 303 miles to 990 miles. Note: Typical Alpine field gravel road = 64 feet wide (measured from the base) x 1 mile x 5,280 ft./mi. = 7.5 acres/mile of road.
6. Assume each central processing/gas compressor facility has one gravel airstrip 100 ft. wide x 5,000 ft. long = 11 acres. There are 11 projected central processing facilities and 45 projected central processing/gas compressor facilities under the Alternative D example.

7. Feeder pipeline miles (oil): Assume total distances of each production pad to central processing facility by economic zone to be: 50 mi (for economic zone 110), 45 mi (for economic zone 120), 24 mi (for economic zone 130), 20 mi (for economic zone 210), and 45 mi (for economic zone 220) = 184 miles total. Vertical support member long-term disturbance includes the vegetation displaced by the vertical support member and a zone around the vertical support member that is approximately 20" wide. This zone of disturbance results from spoils material deposited around the vertical support members and from thermokarst, which may result in a change in species composition. Thus, vertical support member permanent disturbance is comprised of the diameter of the vertical support member—12 in.—plus an area 20 in. from the vertical support member (area = πr2 = 3.14 x 262 sq. in = 2,123 sq. in. = 14.74 sq. ft.). Example: Alternatives A, C or D, short-term disturbance = (35 ft.-wide ice road/snow trail x 5,280 ft./mi x 184 mi) + (14.74 sq. ft. x 150 vertical support members/mi x 184 mi) = 780 acres + 9 acre = 789 total acres. Long-term disturbance = (14.74 sq. ft. x 150 vertical support member/mile x 184 miles) = 9 acres total. Example Alternative B-1: Assume total distances of each production pad to central processing facility by economic zone to be: 25 mi (for economic zone 110), 0 mi (for economic zone 120), 24 mi (for economic zone 130), 20 mi (for economic zone 210), and 45 mi (for economic zone 220) = 114 miles total. Short-term disturbance = (35 ft.-wide ice road/snow trail x 5,280 ft./mi x 114 mi) + (14.74 sq. ft. x 150 vertical support members/mi x 114 mi) = 483 acres + 6 acre = 489 total acres. Long-term disturbance = (14.74 sq. ft. x 150 vertical support members/mile x 114 miles) = 6 acres total.
8. Using regional oil pipeline distances from Table A3-1 (Attanasi and Freeman, 2011) and modified to subtract nonfederal acreage distances (60 mi from each economic zone) from eastern NPR-A border to Pump Station #1 of Trans-Alaska Pipeline System: Alternatives A, C and D: Short-term disturbance = (35 ft.-wide ice road x 5,280 ft./mile x 502 mi) + (14.74 sq. ft. x 81 vertical support members/mile x 502 miles) = 2,142 acres. Long-term disturbance = (14.74 sq. ft. x 81 vertical support members/mile x 502 miles) = 14 acre. Alternative B-1: Short-term disturbance = (35 ft.-wide ice road x 5,280 ft./mile x 359 mi) + (14.74 sq. ft. x 81 vertical support members/mile x 359 miles) = 1,532 acres. Long-term disturbance = (14.74 sq. ft. x 81 vertical support members/mile x 359 miles) = 10 acres.
9. Using feeder pipeline distances from Table A3-1 (Attanasi and Freeman 2011), assume 50-ft-wide buried gas line construction right of way (ice road+trench+spoils) x 1,638 miles x 5,280 ft./mile = 9,927 acres total short-term disturbance for Alternative D example. There are 10 miles of gas pipeline x 6 central processing/gas compressor facilities for economic zone 110; 15 miles of gas pipeline x 6 gas compressor facilities for economic zone 120; 12 miles of gas pipeline x 0 gas compressor facilities economic zone 130; 10 miles of gas pipeline x 6 gas compressor facilities for economic zone 210; 15 miles of gas pipeline x 9 gas compressor facilities for economic zone 220; and 70 miles of gas pipeline x 15 central processing/gas compressor facilities for economic zone 230 = 1,440 miles + 258 total miles of gas pipeline from each accumulation to its respective central processing/gas compressor facilities = 1,395 miles + 243 miles (4.962 x 49 = 243 miles) = 1,638 miles total. (50 ft. x 1,638 mile x 5,280 ft./mile = 9,927 acres). While the long-term impacts of a buried pipeline are not as obvious or severe to the existing ecology as a gravel pad, soils and vegetation are disturbed by both the digging of the ditch and the laying down and attempted replacement of spoils. The recovered vegetation may vary from that existing prior to excavation. The long-term disturbed area in the table reflects the potential for these sorts of disturbance for the width of the trench (4 feet) and the area in which spoils are laid down (11 feet).
10. Using gas pipeline distances from Table A3-1 (Attanasi and Freeman 2011), assume 50-ft-wide buried gas line construction right of way (ice road+trench+spoils) x 360 miles x 5,280 ft./mile = 2,182 acres total short-term disturbance. Example Alternative D: There are 20 miles of gas pipeline for economic zone 110; 70 miles of gas pipeline for economic zone 120; 0 miles of gas pipeline for economic zone 130, 20 miles of gas pipeline for economic zone 210; 70 miles of gas pipeline for economic zone 220; and 180 miles of gas pipeline for economic zone 230 (20 miles + 70 miles + 0 miles + 20 miles + 70 miles + 180 miles = 360 miles total). See note 9 for a discussion of the estimate of long-term disturbance of a buried pipeline.
11. Distance measured from Inigok to eastern NPR-A border near Nuiqsut. Assume 50-ft-wide buried gas line construction right of way (ice road) x 50 miles x 5,280 ft./mile = 303 acres total short-term disturbance for all alternatives. See note 9 for a discussion of the estimate of long-term disturbance of a buried pipeline.
12. Based on booster pump required every 120 oil pipeline miles from production source. Only economic zones 130 and 220 have oil pipelines > than 120 miles. Note: Probability of the occurrence of oil accumulations in economic zone 230 is less than 1 for all size classes (see Table A2-3 of Attanasi and Freeman 2011). Therefore, no regional oil pipeline is assumed for economic zone 230.
13. Based on compressor stations required every 120 gas-pipeline miles from production source. Only economic zone 230 has a gas pipeline longer than 120 miles.
14. Assumed 4 to 8 staging bases (depending on number of accumulations to be developed by alternative) of 50 acres each to be used during 20-year exploratory phase.
15. The number of gravel pits is assumed to be no more than the number of oil and gas central processing facilities. Gravel sources are scarce on the coastal plain, so it is likely that some gravel sources will be used for more than one oil or gas development. The number of acres of gravel pits is based on the assumption that one acre of a gravel pit will meet the gravel needs for five acres of gravel pad, road, airstrip, or other development.
16. Assume (50 miles of ice road/yr. x 20 yrs. of exploration x # central processing/gas compressor facilities) + (50 miles of ice road/yr. x 20 yrs. field and satellite development x # central processing/gas compressor facilities) + (No. of pipeline miles per alternative). For example: Alternative D = (50 miles x 20 yrs. exploration x 53 (11 oil CPFs + 42 gas compressor facilities) central processing/gas compressor facilities + (50 miles x 20 yrs. development x 53 central processing/gas compressor facilities) + (2,734 miles of feeder (oil and gas), regional (oil and gas), and high-pressure (gas) pipelines) = (53,000 miles + 53,000 miles + 2,734 pipeline miles) = 108,734 miles total. Long-term acreage disturbance not calculated but assumed to be negligible.
17. Assume the number of ice runways ranges from 4 to 6 (Alternative dependent) per year during the 20-year exploration phase. Ice runway = 100 ft. wide x 5,000 ft. long = 11 acres. Long-term acreage disturbance not calculated but assumed to be negligible.

Surface Disturbance and Total NPR-A Oil and Gas Production by Alternative

This section summarizes the anticipated oil and gas infrastructure surface disturbance and oil and gas production by alternative. Table 4-14 totals the surface disturbance anticipated to occur over time in the NPR-A attributable to development of discovered oil and gas in the Greater Mooses Tooth and Bear Tooth units (Table 4-7, page 54) and near Umiat (Table 4-8, page 55) and the undiscovered oil and nonassociated gas calculated based on the USGS's 2011 assessment (Table 4-13, page 72). Table 4-15 on page 80 totals the assumed economically recoverable oil and gas from the discovered and undiscovered sources.

Table 4-14. Estimated surface disturbance for discovered and undiscovered oil and gas-related activities under each alternative

Facility	Alternative A			Alternative B-1			Alternative B-2 Preferred Alternative			Alternative C			Alternative D		
	No.	Disturbance (acres)		No.	Disturbance (acres)		No.	Disturbance (acres)		No.	Disturbance (acres)		No.	Disturbance (acres)	
		Short term	Long term		Short term	Long term		Short term	Long term		Short term	Long term		Short term	Long term
Oil exploration wells (6 acres each)	30	180	< 1	16	96	< 1	20	120	< 1	30	180	< 1	30	180	< 1
Gas exploration wells (6 acres each)	68	408	< 1	48	288	< 1	56	336	< 1	92	552	< 1	98	588	< 1
Oil delineation wells (6 acres each)	30	180	< 1	16	96	< 1	20	120	< 1	30	180	<1	30	180	< 1
Gas delineation wells (6 acres each)	68	408	< 1	48	288	< 1	56	336	< 1	92	552	< 1	98	588	< 1
Central processing facility (oil) (one 10-acre; others 40 acres)	12	450	450	9	330	330	8	320	320	12	450	450	12	450	450

Table 4-14. Estimated surface disturbance for discovered and undiscovered oil and gas-related activities under each alternative

Facility	Alternative A			Alternative B-1			Alternative B-2 Preferred Alternative			Alternative C			Alternative D		
	No.	Disturbance (acres)		No.	Disturbance (acres)		No.	Disturbance (acres)		No.	Disturbance (acres)		No.	Disturbance (acres)	
		Short term	Long term		Short term	Long term		Short term	Long term		Short term	Long term		Short term	Long term
Gravel production pad (oil)	16	108	108	14	88	88	14	88	88	15	98	98	16	108	108
Gravel production pad/central processing gas compressor facility (nonassociated gas) (10 acres each)	27	270	270	19	190	190	21	210	210	39	390	390	42	420	420
Gravel production pad (nonassociated gas) (6 acres each)	60	360	360	42	252	252	47	282	282	94	564	564	103	618	618
In-field gravel roads (miles; 7.5 acres/mile)	701	5,258	5,258	496	3,720	3,720	566	4,245	4,245	971	7,283	7,283	1,046	7,845	7,845
Gravel runway (11 acres each)	38	418	418	27	297	297	29	319	319	50	550	550	53	583	583

Table 4-14. Estimated surface disturbance for discovered and undiscovered oil and gas-related activities under each alternative

Facility	Alternative A			Alternative B-1			Alternative B-2 Preferred Alternative			Alternative C			Alternative D		
	No.	Disturbance (acres)		No.	Disturbance (acres)		No.	Disturbance (acres)		No.	Disturbance (acres)		No.	Disturbance (acres)	
		Short term	Long term		Short term	Long term		Short term	Long term		Short term	Long term		Short term	Long term
Three-phase produced fluids (oil, gas, water) gathering/ feeder lines (miles)	224	950	11	154	653	8	154	653	8	224	950	11	224	950	11
Regional oil pipelines (miles)	594	2,519	16	451	1,912	12	451	1,912	12	594	2,519	16	594	2,519	16
Two-phase produced fluids (gas and natural gas liquids) gathering/ feeder lines (miles)	532	3,225	968	452	2,740	822	557	3,376	1,014	1,621	9,824	2,947	1,666	10,097	3,029
Regional gas pipelines (miles)	180	1,091	327	290	1,758	528	290	1,758	528	360	2,182	655	360	2,182	655
High pressure gas line from Inigok (miles)	50	303	91	50	303	91	50	303	91	50	303	91	50	303	91

Table 4-14. Estimated surface disturbance for discovered and undiscovered oil and gas-related activities under each alternative

Facility	Alternative A			Alternative B-1			Alternative B-2 Preferred Alternative			Alternative C			Alternative D		
	No.	Disturbance (acres)		No.	Disturbance (acres)		No.	Disturbance (acres)		No.	Disturbance (acres)		No.	Disturbance (acres)	
		Short term	Long term		Short term	Long term		Short term	Long term		Short term	Long term		Short term	Long term
Booster pump stations (oil) (5 acres each)	2	10	10	2	10	10	2	10	10	2	10	10	2	10	10
Compressor stations (gas) (5 acres each)	0	0	0	0	0	0	0	0	0	1	5	5	1	5	5
Staging bases (50 acres each)	4	200	200	3	150	150	3	150	150	6	300	300	8	400	400
Gravel pits	≤ 40	1,415	1,415	≤ 29	1,007	1,007	≤ 31	1,125	1,125	≤ 52	1,941	1,941	≤ 55	2,088	2,088
Ice road/snow-packed trails (miles; 4.24 acres/mile)	77,240	324,408	0	55,237	231,995	0	59,342	249,246	0	102,689	431,294	0	108,734	456,683	0
Ice airstrips (11 acres each)	100	1,100	0	65	715	0	65	715	0	125	1,375	0	120	1,320	0
Total acres		**343,261**	**9,902**		**246,888**	**7,505**		**265,264**	**8,402**		**461,502**	**15,311**		**488,117**	**16,329**

Table 4-15. Discovered and undiscovered oil and gas economic resource estimates for each alternative

Alternative	A	B-1	B-2	C	D
Oil (millions of barrels)	723	505	549	707	761
Gas (trillion cubic feet)	10.099	8.411	8.738	5.387	17.391

4.2.2 Spills and Releases

This section summarizes the spill or release estimates, behavior, and potential impacts that might result from oil and gas leasing and the potential exploration development and production. This analysis considers a variety of accidental spills, including crude and refined oil, produced water and seawater, and gas releases. These scenarios are conceptual views of the future and represent possible sets of potential accidents. The primary purpose of a scenario is to provide a common basis for the analysis of potential environmental impacts, should future accidents occur. For further details, please refer to appendix G.

The frequency of and impacts from oil spills on the Alaska North Slope have received extensive analysis and review in several recent environmental impact statements, environmental assessments, and other reports. Though the details differ among several of the documents, the basic data and conclusions are generally similar. We incorporate these documents by reference and summarize the key points in this IAP/EIS. Referenced documents include the following:

- Chukchi Sea Sale 193 SEIS (USDOI Bureau of Ocean Energy Management 2011)
- Northeast National Petroleum Reserve - Alaska Final Supplemental IAP/EIS (USDOI BLM 2008)
- Northeast National Petroleum Reserve - Alaska Final Amended IAP/EIS (USDOI BLM 2005)
- Northwest National Petroleum Reserve - Alaska Final IAP/EIS (USDOI BLM and MMS 2003)
- Northeast National Petroleum Reserve - Alaska Final IAP/EIS (USDOI BLM and MMS 1998)
- Alpine Satellite Development Plan EIS (USDOI BLM 2004c)

In the NPR-A planning area, spills could occur from pipelines, storage tanks, production and exploration facilities and infrastructure, drilling rigs (well-control incidents), airstrips, roads, vessels, and bridges. Spills that leave the pads and roadbeds, or enter water sources directly, could reach one or more of several habitat types, including wet and dry tundra, tundra ponds, lakes, flowing creeks and rivers, and potentially the adjacent nearshore Beaufort or Chukchi Sea. Spills could occur any time during the year.

In addition to hydrocarbon spills, spills of other types of materials are reported and tracked. For instance, seawater and produced water spills can be quite large and have the potential to affect large areas. Seawater spills to fresh water can have significant impact. Other types of spills that are reported and tracked include spills of sewage and hazardous materials. This analysis focuses on the chance of occurrence over the life of the oil and gas scenario and the potential impacts of hydrocarbon spills, gas leaks and produced water or seawater spills.

4.2.2.1 Oil Spills

The 34-year North Slope oil industry history shows that the vast majority of the oil, produced water, seawater, and other material spills that have occurred have been very small (less than 10 gallons; ¼ barrel) and few have been greater than 100,000 gallons (2,380 barrels).

A National Research Council (2003) report titled Cumulative Environmental Effects of Oil and Gas Activities on Alaska's North Slope summarized the history of North Slope oil spills at that time: "Major oil spills have not occurred on the North Slope or adjacent areas as a result of operations [of the oil fields] . . . . Many small terrestrial spills have occurred in the oil fields, but they have not been frequent or large enough for their effects to have accumulated. They have contaminated gravel, which has been difficult to clean up and has made the gravel unavailable for rehabilitation." Appendices F and G of the same National Research Council report provide the most recent detailed analysis of size, frequency distribution, type, and general impacts of Alaska North Slope oil spills. These analyses are the basis for the above-quoted conclusion. More recently, in 2006, a large spill occurred from a 34-inch diameter crude oil transit pipeline known as the GC-2 spill. It was estimated at 212,252 gallons, or 5,054 barrels, and is the largest recorded North Slope industry crude oil spill to date. The spill volume was large, because it was a small leak from a low-pressure line that went undetected by mass balance line pack compensation (MBLPC) or pressure point analysis (PPA) for some time. Yet the same conditions that allowed it to continue undetected (snow cover and low temperatures) limited the spread of oil and environmental impact to approximately 2 acres. The estimated large crude oil spill sizes computed in this report for large spills take the GC-2 spill into account and increase the estimated spill size notably from similar analyses written prior to 2006.

Most Alaskan North Slope industry spills have been contained on gravel pads and roadbeds (National Research Council 2003), and most of those that have reached the tundra have covered fewer than 5 acres (Nuka Research and Planning, 2010). Also, as noted above, snow cover and low temperatures through much of the year also reduce the ability of leaked oil to spread as well as impede visual detection if there is a leak below the MBLPC or PPA minimum leak-detection threshold of less than 1 percent based on the daily rate. Upon detection, spills have been promptly contained and cleaned up as required by State, federal, and North Slope Borough regulations (National Research Council 2003).

When a large spill occurs, significant analysis takes place on the causal factors that contributed to the event. Lessons learned from the GC-2 spill have contributed to The Pipeline Inspection, Protection, Enforcement and Safety Act of 2006, signed by President George W. Bush on December 29, 2006. The act extends the oversight jurisdiction of the U.S. Department of Transportation to oil and gas pipelines operating at low pressure, like the GC-2 transit pipeline.

NPR-A Oil Spill Analysis

The information, models, and assumptions used to analyze the potential for oil spills are described in Appendix G. Estimating an oil spill is an exercise in probability, based on historic Alaska North Slope oil spill data. There is uncertainty in the location, number, and size of any spills, the physical and chemical properties of spilled oil; and the environmental conditions at the time of a spill. This analysis considers the entire life of the planning area, and much of the information in this section is reflected in the 1998 Northeast IAP/EIS (USDOI BLM and Minerals Management Service 1998), Northeast National Petroleum Reserve-Alaska Amended IAP/EIS (USDOI BLM 2005), and the Northeast National Petroleum Reserve-Alaska Final Supplemental IAP/EIS (USDOI BLM 2008). Recent Alaska North Slope oil spill history has been incorporated into this updated analysis.

The oil-spill analyses in this IAP/EIS are based on three spill-size categories: (1) small spills (less than 500 barrels); (2) large spills (from 500 and less than 120,000 barrels); and (3) very large spills (120,000 barrels or more). This section discusses small and large spills; very large spills are discussed in section 4.11. Over the lifetime of exploration, development, and production of the NPR-A area, the chance of small spills occurring is high, and small spills are estimated to occur. The chance of one or more large spill occurring is low over the life of exploration, development, and production. No large crude oil spills have occurred from Alaska North Slope exploration (1977-2012) or OCS exploration (1981-2012). The chance of a very large spill occurring is very low over the life of exploration and production.

The responses to a spill and amount of oil removed are variable and dependent upon the weather conditions, time of year, location, the size of the spill, and other factors. The amount of oil removed can range from none to effectively all of the oil. By assuming no cleanup in this oil spill analysis, the estimated effects to the resources are overestimated, or greater than what would actually occur.

Large Crude Oil Spills

Of concern to stakeholders are the potential effects of large crude oil spills on the environment. This section summarizes the key variables used for the large oil-spill analysis. For further details on any of these points, please refer to appendix G.

Information on large crude oil spills is based on historical crude oil spill data from the Alaska North Slope. This introduction summarizes the assumptions used to analyze large oil spills, which are a mixture of project-specific information, modeling results, statistical analysis, and professional judgment. Crude oil spills from the Trans-Alaska Pipeline System are included in the analysis of the cumulative case.

Assuming 100 percent of the resource estimates provided in Table 4-15 on page 80 is produced, and using the Alaska North Slope large crude spill rates, a mean large crude spill number is estimated. The BLM estimates less than one large spill may occur during the life of oil exploration and development that might proceed from leasing and existing discoveries in the NPR-A for Alternatives A through D (Table 4-16). It is more likely that no large spills will occur during the life of oil exploration and development. For purposes of analysis, the BLM assumes one large spill occurs from either a pipeline or a facility from each alternative.

For the large crude oil spill analysis, the BLM uses the volume of the largest Alaska North Slope crude oil spill from a facility or pipeline. For pipelines, the largest spill, rounded to the nearest hundred barrels, is 5,100 barrels, and for a facility, the spill size is 900 barrels (Table 4-16).

Table 4-16. Assumed large (500 barrels [bbl] or greater) crude oil spills over the exploration, development, and production life of the National Petroleum Reserve-Alaska

Alternative	Estimated mean large spill number	Assumed number of spills for analysis	Assumed large spill volume (bbl)	Percent chance of one or more large spills
A	0.47	1	900 or 5,100	37
B-1	0.33	1	900 or 5,100	28
B-2	0.36	1	900 or 5,100	30
C	0.46	1	900 or 5,100	37
D	0.49	1	900 or 5,100	39

bbl = barrels; The estimated mean number of oil spills is based on the estimated volume of resources multiplied by the historic Alaska North Slope spill rate. See Appendix G for a detailed explanation.

For analysis purposes, it is assumed the one large crude oil spill occurs from either a pipeline or a facility. A large spill from a facility or pipeline within the NPR-A area could happen at any time during the year. Scenarios were created in which a large crude oil spill could reach any of the following environments:

- Gravel pad and then the tundra, snow, or ice (gravel pad not assumed to retain any oil);
- Open water (lagoon, lake, or river);
- Broken ice (lagoon, lake, or river);
- On top of or under solid ice (lagoon, lake, or river);
- Shoreline (lagoon, lake, or river); or
- Tundra or snow and ice.

Based on oil weathering modeling, the large spill scenario (900 or 5,100 barrels) assumes that after 30 days in open water or broken ice, 29 to 40 percent of the oil evaporates, 3 to 48 percent disperses, and 13 to 56 percent of the oil remains. After 30 days under ice in a lagoon or lake, nearly 100 percent of the oil remains in place and unweathered.

The analysis of the effects of large oil spills is based on the following assumptions:

- One large spill is assumed to occur;
- The spill size is 900 or 5,100 barrels;
- All the oil reaches the environment and the gravel pad absorbs no oil;
- The spill starts at the gravel pad or along a pipeline or from a facility, well, or tank;
- There is no cleanup or containment;
- The oil chemistry is similar to that of Alpine field oil;
- The spill could occur at any time of the year;

- A spill under a lagoon or lake ice from planning area facilities or pipelines does not move substantially until the ice breaks up; and
- Spill locations and dates used in the analyses are those that would result in the greatest impact.

Small Crude and Refined Oil Spills

The consequences of small spills of crude and refined oil are analyzed to address concerns about the chronic effects from numerous small spills. The small spills assumed for this analysis are shown in Table 4-17. For this analysis, it is assumed that:

- Small crude spills can begin anywhere on the gravel pad facilities or along the pipeline;
- Small spills on gravel pads occur in contained areas or are cleaned up and do not reach the environment; and
- Small spills from pipelines are likely to reach the environment.

Onshore or offshore refined-oil spills could occur along ice roads, or from barges, helicopters, airplanes, gravel pad facilities, or trucks along the road system. Typical refined products spilled on the Alaska North Slope are aviation fuel, diesel fuel, engine lube, fuel oil, gasoline, grease, hydraulic oil, transformer oil, and transmission oil. On the Alaska North Slope, diesel spills represent 52 percent of refined oil spills by frequency and 74 percent by volume. Engine lube oil spills are 11 percent by frequency and 5 percent by volume. Hydraulic oil spills are 32 percent by frequency and 13 percent by volume. Aviation fuel is 0.3 percent by frequency and 2 percent by volume. All other categories of refined spills are less than 1 percent by frequency and volume.

Based on the total oil production projected in Table 4-15 on page 80 and historical North Slope crude and refined oil spill rates, the estimated number of small crude oil/refined oil spills for Alternatives A, B, C, and D and the estimated volume in barrels over the exploration, development and production life are shown in Table 4-17.

Table 4-17. Assumed small (less than 500 barrels) crude/refined oil spills for life of National Petroleum Reserve-Alaska

Alternative	Assumed number of small spills[1]	Assumed total small spill volume (bbl)[1]	Percent chance of one or more small spills
A	135/390	405/312	>99.9
B-1	94/273	282/218	>99.9
B-2	103/296	309/237	>99.9
C	132/382	396/306	>99.9
D	142/411	426/329	>99.9

1. The first number is for crude oil spills, while the second number is for refined oil spills; bbl = barrels

The estimated number of oil spills is based on the estimated volume of resources multiplied by the Alaska North Slope small spill rate. See appendix G for a detailed explanation.

Fate and Behavior of Spilled Oil

This section describes the properties and behavior of spilled oil that must be considered when evaluating the potential effects of an oil spill in the various environments of the NPR-A.

The primary processes that affect the fate of spilled oil are spreading, evaporation, dispersion, dissolution, and emulsification (Boehm 1987; Payne et al. 1987; Lehr 2001). These processes, collectively called weathering, dominate during the first few days to weeks of a spill, and, with the exception of dissolution, can dramatically change the nature of the oil. A number of longer-term processes also occur, including photo- and biodegradation, auto-oxidation, and sedimentation. However, these longer-term processes are more important in the later stages of weathering, and usually determine the ultimate fate of the spilled oil.

The chemical and physical composition of oil changes with weathering. Some oils weather rapidly and undergo extensive changes in physical and chemical composition, whereas others remain relatively unchanged over long periods of time. As a result of evaporation, the effects of weathering are generally rapid (i.e., occurring in 1 to 2 days) for hydrocarbons with lower molecular weights. Degradation of the higher weight fractions is slower and occurs primarily through microbial degradation and chemical oxidation.

The spreading of oil on water reduces the bulk quantity of oil present in the vicinity of the spill, but increases the spatial area over which effects from oil may occur. Thus, oil in flowing systems (as opposed to contained systems) would be less concentrated in any given location, but may cause impacts over a much larger area. Spreading and thinning of spilled oil also increase the surface area of the slick, enhancing surface-dependent fate processes such as evaporation, degradation, and dissolution.

Evaporation is the primary mechanism for loss of low molecular weight constituents and light oil products. As lighter components evaporate, the remaining petroleum product becomes denser and more viscous. Evaporation tends to reduce oil toxicity but enhance persistence. Hydrocarbons that volatilize into the atmosphere are broken down by sunlight into smaller compounds. This process, referred to as photodegradation, occurs rapidly in air, and the rate of photodegradation increases as the molecular weight increases.

Dispersion of oil increases with increasing surface turbulence. The dispersion of oil into water may increase the surface area of oil susceptible to dissolution and degradation processes, and thereby, limit the potential for physical impacts.

Dissolution of oil in water is not a major process controlling the oil's fate in the environment. However, it is one of the primary processes affecting the toxic effects of a spill, especially in confined waterbodies. Dissolution increases with (1) decreasing molecular weight, (2) increasing temperature, (3) decreasing salinity, and (4) increasing concentration of dissolved organic matter.

Emulsification, the incorporation of water into oil, is the opposite of dispersion. During emulsification, external energy from wave action causes small drops of water to become surrounded by oil. In general, heavier oils emulsify more rapidly than lighter oils. The emulsified oil may remain in a slick, which can contain as much as 70 percent water by weight and can have a viscosity a hundred to a thousand times greater than the original oil. Water-in-oil emulsions often are referred to as "mousse."

Photodegradation of oil increases with greater solar intensity. It can be an important factor in causing the disappearance of a slick, especially one composed of lighter products and constituents; however, it is less important during cloudy days and can be nonexistent during the winter months on the North Slope. Photodegraded constituents of petroleum products tend to be more soluble and more toxic than their parent compounds. Therefore, photodegradation may increase the solubility and toxicity, and thus, increase the biological impacts of a spill event.

In the immediate aftermath of a spill, natural biodegradation of oil is not typically an important process controlling the fate of oil in waterbodies previously unexposed to oil. Microbial populations must become established before biodegradation can proceed at any appreciable rate.

Overall, because the environmental fate of released oil is controlled by many factors, its persistence is difficult to predict with great accuracy. Besides the primary processes discussed in the preceding paragraphs, major factors affecting the environmental fate include the type of product, spill volume, spill rate, temperature of the oil, terrain, receiving environment, time of year, and weather. For example, because of their physical and chemical properties, both diesel and refined oil evaporate at a substantially faster rate than crude oil.

The characteristics of the receiving environment, such as type of land; the surface gradient; and whether it is marine or freshwater, surface or subsurface, spring ice overflow, summer open water, winter under ice, or winter broken ice, would affect how the spill behaves. In ice-covered waters, many open water weathering processes occur; however, the ice changes the rates and relative importance of these processes (Payne et al. 1991).

The time of year in which a spill occurs also has a major effect on the fate of the crude oil, as it is linked to climatic factors such as temperature of the air, water, or soil; depth of snow cover; whether there is ice or open water; and the depth of the active layer. During winter, the air temperature can be so cold that it modifies the viscosity of the oil, limiting its spread, and sometimes even causing it to gel. The lower the ambient temperature, the less crude oil evaporates, as demonstrated experimentally by both Prudhoe Bay and Endicott crudes (Fingas 1996). Frozen ground limits the depth of penetration of any spill, and ice acts as a barrier to penetration until it melts.

Spills on Tundra

Oil movement over the ground surface follows the topography of the land (i.e., oil flows downhill). In general, oil flows until it reaches a surface water body or a depression, or until absorption prevents further movement. Oil flowing over land can infiltrate vegetative cover, soil, and snow. If released onto tundra, oil can penetrate the soil as a result of the effects of gravity and capillary action, with the rate of penetration depending on the season, the nature of the soil, and the type of petroleum product. In summer, spills can penetrate the active layer (the layer of soil and rock that thaws each summer and freezes each winter, which overlies the permafrost layer of permanently frozen soil and rock) and then spread laterally on the frozen subsurface, accumulating in local topographic depressions. From there, the oil can penetrate into the permafrost (Collins et al. 1993). Precipitation may increase penetration into thawed soils/active layer (Solntseva 1998 in Chuvilin et al. 2001).

In winter, when the ground and water surfaces are frozen, spreading is controlled by the snow cover or frozen soil. Snow cover can act as an absorbent, slowing the spread of oil or preventing the spill from reaching the tundra surface. Oil tends to spread on the surface of the frozen soil, and penetration of oil into the soil is limited. However, any soil pore space that is not filled with ice may allow spilled oil to move into the frozen soil (Yershov et al. 1997; Chuvilin et al. 2001). On industry gravel pads gradients changed from water flowing into or out of the pad depending upon the time of the season and on precipitation events (Barnes 2010). Water movement will influence spill movement.

Tundra relief on much of the coastal plain of the North Slope is low enough to severely limit the spread of spills. During summer, flat coastal tundra develops a dead-storage capacity averaging a depth of 0.5 to 2.3 inches (Miller et al. 1980), which would retain 300 to 1,500 barrels of oil per acre. Even at high water levels, the tundra vegetation tends to limit the spread of oil, with both vegetation and peat functioning as sorbents that allow water to filter through, trapping the more viscous oil (Barsdate et al. 1980), but making recovery of the oil more difficult. On the other hand, even small spills can be spread over large areas if the spill event includes aerial, pressurized discharge. With the high-velocity, bi-directional winds on the North Slope, oil can be misted miles downwind of a leak. For example, in December 1993, an ARCO drill site line failed, and 1 to 4 barrels of crude oil misted over an estimated 100 to 145 acres (Ott 1997). Additionally, in late May or early June, the ice in the northern Alaska rivers breaks up, causing a rapid flood event termed "break-up," that, combined with ice and snow damming, can inundate large areas in a matter of days. A spill during break-up could be spread over a significantly larger area by the flooding water.

Spills into Water

Oil spreading on the water surface (but not necessarily the transport of oil by moving water) would be restricted in most planning area waters. Because of the increased viscosity (a property that reduces spreading) of oil in cold water, oil spills in planning area lake, river, and marine waters would spread less than those in temperate fresh or marine waters. The exception would be a spill in shallow, marshy, or ponded tundra or flooded lake margins during summer, which could spread similarly to a temperate spill. These shallower waters can reach temperatures up to 64 degrees Fahrenheit, which is generally warmer than other tundra waters (Miller et al. 1980), and warm enough to lower oil slick viscosity.

With knowledge of the time of year and the expected ice conditions, one can predict the likely configuration of oil spilled under, in, on, or among ice with a fair degree of confidence, which can be used to plan appropriate strategies for monitoring and responding to spills (Dickins et al. 2000).

Oil spilled onto the ice surface is prevented from spreading rapidly by the presence of snow and natural small-scale ice roughness (Dickins et al. 2000). An oil spill in broken ice would not spread as far as one in open water, particularly in the initial stages of a spill. Oil would spread between ice floes into any gaps greater than about 3 to 6 inches

(Free et al. 1982). Environmental conditions can be highly variable during fall freeze-up and spring break-up. The environmental conditions encountered during freeze-up are different than those encountered during break-up, and the behavior of ice during break-up and freeze-up is complex, varying greatly from year to year and from site to site. Additionally, at freeze-up and break-up, the timing and duration of ice break-up, and ice formation/decay processes differ greatly between shallow nearshore locations and deeper water sites (Dickins et al. 2000).

An oil spill under ice typically behaves in the general manner described below:

- The oil rises to the under-ice surface and spreads laterally, accumulating in the under-ice cavities. Because of under-ice storage capacity and low under-ice currents, oil spilled under stable landfast ice does not spread more than a few hundred feet from the spill site.
- For spills occurring when the ice sheet is still growing (typically from freeze-up until April), the pooled oil is encapsulated in the growing ice sheet. The presence of any substantial coverage of developing ice limits the spreading of spilled oil, as compared to a similar spill in open water.
- During break-up, as the ice begins to deteriorate, the encapsulated oil rises to the surface through brine channels in the ice (Glaeser and Vance 1971; Keevil and Ramseier 1975; NORCOR Engineering and Research 1975; Purves 1978; Martin 1979; Dickins and Buist 1981; Kisil 1981; Buist and Dickins 1983; Comfort et al. 1983; Dickins et al. 2000).

The spread of oil under ice can be affected by the presence of currents, if the magnitude of those currents is large enough. Laboratory tests have shown that currents in excess of 6 to 10 inches per second are required to strip oil from under-ice depressions (Cammaert 1980; Cox et al. 1980). Current speeds in the nearshore Beaufort Sea are generally are less than 4 inches per second during the winter (Weingartner and Okkonen 2001); speeds that were shown to be insufficient to strip oil from under an ice sheet after the oil had ceased to spread in field study near Cape Parry in the Northwest Territories (NORCOR Engineering and Research 1975). The area of contamination under ice could increase if the ice were to move. However, because the nearshore Beaufort and Chukchi Seas are in the landfast ice area, the spread of oil due to ice movement would not be anticipated until spring break-up.

Weathering processes generally would be similar in freshwater and coastal marine regimes, with seasonal ice cover capable of greatly slowing weathering in both regimes. During winter, weathering of oil depends primarily on whether the oil is exposed to the atmosphere.

Evaporation of oil generally correlates to temperature, with lower temperatures linked to slower evaporation rates of crude oil (Fingas 1996). Oil between, or on, ice is subject to normal evaporation; oil that is frozen into the underside of ice, however, is unlikely to undergo any evaporation until the spring, when the deterioration of multi-year ice causes the encapsulated oil to rise to the surface through brine channels in the ice. For oil spilled during freeze-up, with the likely absence of wave action, evaporation is the only major weathering process (Dickins et al. 2000). Evaporation occurs as oil is released to the surface. Because freshwater and first year ice do not have enough salts to form brine channels, oil is released only as the ice surface melts to the level of the encapsulated oil. For freshwater ice, evaporation occurs when the ice becomes porous within about 2 weeks of meltout (from May to July, depending on weather, ice thickness, and location of the oil in the ice). In multi-year ice, oil typically does not surface until August, with some oil not being released until the following summer.

Dispersion of oil spills in water occurs from wind, waves, currents, or ice. Any waves within the ice pack tend to pump oil onto the ice. Some additional oil dispersion occurs in dense, broken ice through floe-grinding action. More viscous and/or weathered crude oil may adhere to porous ice floes, essentially concentrating oil within the floe field and limiting the oil dispersion. North Slope crude oil readily emulsifies to form stable emulsions, a process that sometimes increases in the presence of ice. With floe grinding, Prudhoe Bay crude forms a mousse within a few hours and much more rapidly than in open water.

In most cases, the weathering processes acting on oil in and along streams or rivers are similar to those described above for freshwater or marine spills. The dynamics of a river or stream environment, however, have additional effects on the fate and behavior of spilled oil. Oil entering rivers and streams begins to spread as in freshwater or marine spills, but the spreading motion is rapidly overcome by the surface current, at which point an elongated slick forms. The oil flows downstream at the speed of the current in the absence of wind effects. In general, oil tends to accumulate in areas of quiet water or eddies at the inside of river bends on a meandering river or stream, or in other pools where velocities are slower. Pools of oil may also accumulate behind log or debris jams. Water near the center of a stream channel flows faster than water near the banks or bottom of the channel where the retarding forces of friction with the channel are greater. This difference in current speed and the resulting shearing forces between water layers is typically the major mixing mechanism that spreads a slick out as it moves downstream. The resulting shearing of the oil distribution along the axis of flow controls the plume shape and size, and the distance over which the oil concentration remains above a particular level of concern. The leading edge of the slick may move as a relatively sharp front (at the mid-channel current speed); however, mixing continuously exchanges water and oil between the slower, near-bank regions and the faster-flowing, center regions of the river. From a practical point of view, this means that although it might be possible to predict the initial arrival of oil at a point along the river, it is considerably more difficult to estimate when the threat is past, since the areas of slower currents may continue to supply oil to the main stream channel, even after the leading edge is past (Overstreet and Galt 1995).

Shear-dominated flows cause another effect that characterizes river spills. Shear in currents along the banks and river bottom is typically the major source of turbulence in rivers, in contrast to surface-wave activity in oceans. Mixing and dispersion caused by the interaction of the shear and the turbulence can move large amounts of oil below the surface (particularly if it is relatively dense, such as heavy No. 6 oil, or if it is finely distributed as droplets). The shear-dominated river regimes tend to produce spill distributions with higher subsurface oil concentrations than would be expected in marine spills (Overstreet and Galt 1995). This turbulence increases with increased velocity of flow and bed roughness.

The National Petroleum Reserve – Alaska Oil-Spill Experiment

In July 1970, 5 barrels of Prudhoe Bay crude was experimentally spilled in a 0.07-acre tundra pond in the NPR-A near Barrow (Miller et al. 1978; Barsdate et al. 1980; Hobbie 1982). The general behavior of this experimental spill is instructive about what would be expected from a small spill in the planning area during the summer, or from a winter spill that melts out during thaw.

In this experimental spill, the oil spread over the water surface within a few hours to a 0.06-inch thickness. Within 24 hours, the slick thickened as lighter hydrocarbons evaporated, and shrank into a 10- to 16-foot band on the downwind side of the pond. For about a month, the oil moved back and forth across the pond, shifting sides with changes in wind direction. Gradually, the oil worked part way into the pond's vegetated margins. By the end of summer, all of the oil was trapped along the pond margins, either on the water's surface or on the bottom. No oil left the pond during the next spring runoff, despite substantial water throughflow. No cleanup of the oil was conducted in this experiment.

Roughly half of the oil was estimated to have evaporated or degraded within a year, but the rest of the oil remained with little change for at least 5 years; but there was some loss of those hydrocarbon compounds with fewer than 13 carbon atoms (presumable from biological degradation (Barsdate et al. 1980). Barsdate et al., (1980) concluded the following:

> The experimental spill had no major effect on the numbers and production of chironomids, but there were some minor effects on their emergence . One genus, Tanytarsus, was nearly eliminated from the ponds. Beetles, caddisflies, stoneflies, and snails were also drastically affected; most of these animals live only in the plant beds and may have become trapped in the oil on plant stems and in the floating oil. These insects were still absent in Pond E 6 years after the spill.

4.2.2.2 Gas Releases

The gas produced in the NPR-A is expected to be dry gas (no water or condensates). This analysis identifies three general types of potential gas releases: (1) from loss of well control at production areas, (2) from ruptured gas pipelines, and (3) from gas processing facilities. This section summarizes the key variables used for gas release analysis. For further details on any of these points, please refer to appendix G.

Loss of well control is estimated at 3.6 x 10-4 gas blowouts per exploration well and 7.0 x 10-4 gas blowouts per development well drilled by the International Association of Oil and Gas Producers (2010). The production well-control incident rate for production of gas is 5.7 x 10-5 blowouts per well year (OGP 2010). On February 15, 2012, Repsol had a loss of well control from an exploration well on the Alaska North Slope. The loss of well control, from a shallow gas pocket, released gas and drilling mud. While gas blowouts occur at a very low frequency, for purposes of analysis, a well-control incident was assumed to occur and the impacts of a gas release from a well were analyzed.

For a 300-mile onshore pipeline, over a 20-year production life, the estimated number of significant incidents using the Department of Transportation's estimated gas transmission pipeline rate is 0.9 significant incidents over the life of the project. Since pipeline length could vary, the BLM uses a 300-mile pipeline to be conservative, for NEPA analyses. A shorter pipeline would have a lower frequency of incidents. Under the Department of Transportation regulation, significant incidents are incidents that involve property damage of more than $50,000, injury, death, release of gas, or that are otherwise considered significant by the operator. It should be noted that the major cause of Department of Transportation transmission and distribution pipeline accidents is damage by digging or impact near existing pipelines. The limited population and activity on the Alaska North Slope could likely reduce the frequency of these causal factors.

Although unlikely, due to the enclosed space, there exists some potential for a gas leak and explosion at an onshore facility. The greatest hazard as a result of a natural gas leak is a fire or explosion. Methane has an auto-ignition temperature of 1,000 degrees Fahrenheit and is flammable at concentrations between 5 to 15 percent in air. Unconfined mixtures of methane in air are not explosive. However, a flammable concentration within an enclosed space in the presence of an ignition source can result in a potential explosion hazard.

A release from a well is estimated to last one day and release 10 million cubic feet of natural gas. A release from a ruptured transmission pipeline or gas processing facility is estimated to release 20 million cubic feet over a few hours. These releases would be localized to the area adjacent to the release site. Thermal effects are estimated to be within 500 meters of the ignition source.

Gas Release Fate

Natural gas is primarily made of up methane CH4 and ethane C2H6, which make up 85 to 90 percent of the volume of the mixture. The primary component of natural gas is methane, a colorless, odorless, and tasteless gas. It is not toxic in the atmosphere, but is classified as a simple asphyxiate, possessing an inhalation hazard. As with all gases, if inhaled in high enough concentration, oxygen deficiency could occur and result in suffocation in an enclosed space. The specific gravity of methane is 0.55 (Air = 1.0). Being lighter than ambient air, it has the tendency to rise and dissipate into the atmosphere. Onshore, from an elevated pipeline, the gas would disperse into the atmosphere. Underground, from a buried pipeline release, the gas would bubble to the surface and continue into the atmosphere, where it would dissipate.

Natural gas releases pose a primarily acute hazard. Hazards associated with natural gas are predominantly flammable in nature. If an ignition source exists, a release of gas can result in an immediate fire or explosion near the point of the release. This hazard is reduced over a relatively short period after the release ends as the gas disperses. If the vapors accumulate in a processing facility or compressor station, then the hazard may remain longer.

4.2.2.3 Large Seawater and Produced Water Spills

Of concern to stakeholders are the potential effects of large seawater or produced or processed water spills on tundra or freshwater habitat. This section summarizes the key variables used for large seawater and process or produced water spill analysis. For further details on any of these points, please refer to appendix G.

Information on produced water or seawater spills is based on Alaska North Slope spill data in appendix D of Nuka Research and Planning Group (2010). This section summarizes the assumptions used to analyze large spills of produced water or seawater.

Assuming the amount of oil estimated for each alternative and existing discoveries provided in Table 4-15 on page 80 is produced, and based on Alaska North Slope spill rates, BLM estimates less than one large produced, or seawater spill may occur (Table 4-18). For purposes of analysis, BLM assumes one large spill occurs from a flowline or transmission pipeline for each alternative and the assumed spill size is 1,900 barrels (Table 4-18).

Table 4-18. Assumed large (500 barrels or more) produced water or seawater spills for the development life of the NPR-A

Alternative	Estimated mean large spill number	Assumed number of spills for analysis	Assumed large spill volume (bbl)	Percent chance of one or more large spills
A	0.80	1	1,900	55
B-1	0.56	1	1,900	43
B-2	0.60	1	1,900	44
C	0.78	1	1,900	54
D	0.84	1	1,900	57

The estimated mean number of produced or seawater spills is based on the estimated volume of resources produced, multiplied by the historic Alaska North Slope spill rate. See appendix G for a detailed explanation.

Large Seawater and Produced Water Spill Fate

Spills of seawater and produced water are soluble and mobile in nonfrozen soils. Flushing with water can return surface soil salinity to near-normal conditions within 30 days in wet tundra, but salt may persist longer at moist or dry sites (Simmons et al. 1983). Experimental seawater spills found few effects in wet tundra sites, but live plant cover reduced 61 to 87 percent one year later in dry and moist tundra sites (Simmons et al. 1983).

4.2.2.4 Spill Prevention and Response

Each permittee operating on the NPR-A is required to develop and operate in compliance with an approved Oil Discharge Prevention and Contingency Plan (C-Plan). The plan must describe the spill prevention measures as well as spill response procedures. Each permittee is required to have sufficient trained personnel and clean-up equipment and supplies available to meet federal, State, and North Slope Borough regulations. Sufficient equipment and trained personnel must be available at the site of the activity to provide immediate spill response. Additional equipment and personnel from other locations can be used, such as equipment and personnel made available through Mutual Aid Agreements from other spill response contractors, other North Slope oil fields, North Slope communities, or other sources. Each permittee is also required to have proof of financial responsibility from the State of Alaska (18 AAC § 75.205 and 18 AAC § 75.240).

In the context of spill prevention, an activity site is an exploration site, drilling site, or production site, each with its ancillary facilities. Federal regulations that must be met include BLM oil and gas operating regulations (43 CFR Part 3160, Onshore Order Numbers 1, 2, and 6). These regulations address the prevention and control of oil spills and releases. Regulations 40 CFR Parts 110 and 300 address responses to spills or releases of oil and gas.

Spill response requirements would be thoroughly addressed at the site-specific permit level. For example, an Application for Permit to Drill would be evaluated for spill response regarding storage of chemicals and hydrocarbons on site and oil spill prevention equipment, such as blowout prevention equipment and leak detection systems. These requirements are addressed in Onshore Order No. 2. The Alaska Oil and Gas Conservation Commission is responsible for hydrogen sulfide (H_2S) planning for drilling operations (20 AAC § 25.065), and Onshore Order No. 6 addresses anticipated H2S releases. These conditions are all very site-specific. U.S. Coast Guard regulations may also apply to the transportation and transfer of oil to or from barges or vessels. Alaska Statutes Title 46, chapters 3 and 4 provide the Alaska Department of Environmental Conservation with the authority to prevent and respond to oil discharges. In addition, AS 46.03 and 46.04 provide Alaska Department of Environmental Conservation with civil, criminal, and administrative enforcement authorities. The Alaska Department of Environmental Conservation regulations that apply to oil spill prevention, contingency planning, and response are found in the Alaska Administrative Code (18 AAC Chapter 75).

A spill response plan includes an action plan and a list of contacts in local, State, and federal agencies with direct responsibilities in the event of a spill, as well as private companies that can be called on for further information or assistance. The environmental obligations of operators on a federal onshore lease are described in BLM regulations in 43 CFR Part 3160, Oil and Gas Operating Rules. In addition, parts or all of several Onshore Oil and Gas Orders may apply, as necessary.

Regulations administered by the BLM and the Alaska Oil and Gas Conservation Commission require an operator to maintain well control at all times during drilling and production. The BLM has been delegated the authority to ensure that all exploration or production wells are operated under control.

The BLM has the authority to cite the operator and bring civil and/or criminal charges for specific violations. If there is a spill or release of petroleum fluids or chemicals used in the petroleum industry on the lease, unit, or a participating area, the BLM has the authority to cite the operator and require cleanup of the spill. However, the spill response would be completed in cooperation with other federal and State agencies.

For most spills within the State, the Alaska Department of Environmental Conservation provides a State On-Scene Coordinator. The EPA serves as the federal On-Scene Coordinator for spills that threaten inland waters, and the U.S. Coast Guard is the federal On-Scene Coordinator in tidewater areas and on the seas. (For more information on jurisdictions and roles, see The Alaska federal/State Preparedness Plan for Response to Oil and Hazardous Substance Discharges/Releases, Change 3, January 2010, also known as the Unified Plan.) The federal On-Scene Coordinator and the State On-Scene Coordinator, in coordination with the surface-land manager, monitor and document the operator's actions and may direct cleanup actions when necessary. Depending on the situation, after the event is controlled and the emergency phase deemed past, long-term cleanup efforts and site monitoring will continue under agency programs outside of the Unified Plan.

An exploration or production facility operator is required to include plans for the control and containment of spills, including blowouts, in the Alaska Department of Environmental Conservation-approved contingency plan. The Alaska Department of Environmental

Conservation requires that all oil-spill prevention and contingency plans rely on using mechanical tactics to control, contain, and clean up spills. An example of a nonmechanical tactic is in situ burning, which may be used, upon approval, in appropriate circumstances.

Alaska statutes and Alaska Department of Environmental Conservation regulations require that an operator of an oil exploration or production facility, a terminal facility (storing 5,000 barrels of crude oil or 10,000 barrels of non-crude oil), an oil tank vessel or oil barge, a non-tank vessel of more than 400 gross tons, or a crude oil pipeline have an Oil Discharge Prevention and Contingency Plan approved by Alaska Department of Environmental Conservation before beginning operations (AS 46.04.030 and 18 AAC § 75.400).

Facilities that must have an Alaska Department of Environmental Conservation-approved contingency plan (the plan requirements are in 18 AAC § 75.425) must also meet oil discharge prevention requirements found in 18 AAC § 75.005 to 75.090. Required prevention measures include training programs, operating procedures, monitoring, inspections, and equipment/facility specifications. All crude oil transmission pipelines must meet the leak detection, monitoring, and operating requirements of 18 AAC § 75.055.

Under these State requirements (and allowing reductions for certain additional prevention measures) operators must plan to contain or control the response planning standard volume (18 AAC § 75.430 to .442) of oil reaching open water within 72 hours and to clean up the on-land portion of the spill in the shortest possible time, consistent with minimizing damage to the environment. Environmental conditions can sometimes limit response work.

Severe weather conditions in the Arctic, such as cold temperatures, broken ice, and extreme wind, can pose challenges to spill cleanup and containment. Realistic maximum response operating limitations must be taken into account in spill planning (18 AAC § 75.425(3)(D)).

Section 4.3:
Impacts of Alternative A

4.3 Alternative A

4.3.1 Air Quality and Climate

This section qualitatively describes the potential air quality impacts associated with Alternative A in the Draft IAP. The BLM is preparing an air emissions inventory and a dispersion modeling analysis to refine this qualitative analysis.

4.3.1.1 Activities Not Associated With Oil and Gas Exploration and Development

Air quality impacts would likely continue to occur from diesel-fired generators in small villages, residential heating, snow machines, all-terrain vehicles, occasional small aircraft, limited local vehicle traffic, and occasional open burning. Given its high latitude, the planning area will continue to be subject to occasional air quality impacts from emission sources in northern Europe and Asia (and to a lesser extent, northern Alaska.). In addition, helicopter and fixed-wing aircraft activities are likely to occur each summer. Additional flights would originate out of Deadhorse, Prudhoe Bay, Barrow, and other airfields on the North Slope. These activities would have a transitory effect on local air quality (2008 Northeast NPR-A Supplemental IAP/EIS).

4.3.1.2 Oil and Gas Exploration and Development Activities

Air Pollutant Emission Sources

Oil and gas development and associated activities result in airborne emissions. The primary sources of airborne emissions include construction dust, road dust, vehicle and machinery emissions, flaring, venting of gas, burning of refuse, and emissions from power generation.

The following air pollutants would be produced during activities associated with oil and gas exploration and development under all alternatives: nitrogen oxides, sulfur dioxide, particulate matter (PM, including both $PM_{2.5}$ and PM_{10}), hazardous air pollutants, volatile organic compounds, and greenhouse gases such as carbon dioxide, methane, and nitrous oxide. Combustion emissions may be assumed to be primarily $PM_{2.5}$, while fugitive dust emissions may be assumed to be primarily PM_{10}. The types and amounts of air pollutants generated vary according to the phase of activity.

Regardless of development phase, it is anticipated that helicopter use would occur throughout the planning area under all alternatives. Carbon monoxide is the primary air pollutant that would be emitted. During the exploration/delineation phase, emissions would be produced by (1) drilling equipment required for exploratory and delineation wells, (2) trucks and other vehicles used to support exploration, and (3) intermittent activities such as mud degassing and well testing. Pollutant emissions would consist primarily of carbon monoxide, nitrogen oxides, and sulfur dioxide.

During the construction phase, the principle emission sources include: (1) drilling engines/turbines, (2) heavy construction equipment used to install well modules and pipelines, and (3) ground-based support vehicles and aircraft. The primary development-phase emissions would be carbon monoxide and nitrogen oxides, with lesser amounts of particulate matter and sulfur dioxide.

During the production phase, the primary source of emissions would be power generation for heating, oil pumping, and water injection. The emissions would consist primarily of carbon monoxide and nitrogen oxides, with smaller amounts of particulate matter. There would also be minimal evaporative losses of volatile organic compounds from oil/water separators, pump and compressor seals, valves, and storage tanks. Venting and flaring could be an intermittent source of nitrogen oxides, volatile organic compounds, and possibly sulfur dioxide (2008 Northeast NPR-A Supplemental IAP/EIS).

In addition to these criteria pollutants, certain hazardous air pollutants may also be emitted. Benzene, toluene, ethyl-benzene, xylenes, N-hexane, and formaldehyde are common hazardous air pollutants associated with volatilization of oil and gas resources, as is formaldehyde from compressor engines. Depending on conditions, hydrogen sulfide may also be found in oil.

Effects of Air Pollution

As presented in Table 3–2 in Volume 1, ambient air quality standards have been established for seven air pollutants in order to prevent significant air quality impacts from occurring and thus protect human health and welfare. Under the State Implementation Plan, the Alaska Department of Environmental Quality has jurisdiction for regulating and permitting air quality emissions within the NPR-A. Operators would be required to meet Alaska Department of Environmental Quality's requirements for air emissions, including obtaining construction and operating permits. All BLM activities (whether directly or through use authorizations), must comply with all applicable air quality laws, regulations, standards, increments, and implementation plans.

In general, direct and indirect air quality effects could be short term (hours, days, or weeks), long term (seasons or years), local, or regional (North Slope). Air quality concentrations could increase during construction activities and during production operations. This could result in a decrease in local visibility and an increase in atmospheric deposition.

Once site-specific projects are submitted for authorization, potential air quality impacts could be reduced by limiting the emission sources (fuel characteristics, engine specifications, etc.), spacing (such as separating concurrent drilling operations to reduce combined impacts), limiting the season and timing of operations (to enhance favorable dispersion conditions), and requiring specific control measures (road watering, low nitrogen oxides, flares, etc.). The NEPA Air Quality Memorandum of Understanding (signed June 23, 2011) provides for consideration of mitigation measures such as those identified above. The BLM will consider mitigation measures throughout the NEPA process.

Development and production activities can also produce fugitive dust emissions (primarily as PM_{10}). Fugitive dust occurs primarily during the summer months due to driving on unpaved roads. Vehicles can also track out fine material from gravel mining operations in the winter and summer months. Potential control measures include limiting vehicle speeds, and treating problematic road sections with surfactants or water.

Well closure, abandonment, and reclamation activities would emit air pollutants similarly to those during development (construction), since similar vehicles and other emission sources would be used. Impacts could be minimized by leaving gravel on-site, limiting the amount of transport. Once reclamation is complete, production facilities would no longer impact air quality in the planning area (2008 Northeast NPR-A Supplemental IAP/EIS 2008).

Air quality impacts from Alternative A would contribute some greenhouse gas emissions, though a miniscule amount in the global context. The assessment of greenhouse gas emissions and climate change is in its formative phase. While it is not possible to know with confidence the impact of increased greenhouse gas emissions due to proposed operations within the planning area on global climate change, it is certain that it would contribute a very small amount to climate change.

4.3.1.3 Effectiveness of Stipulations and Required Operating Procedures

Required Operating Procedure A-9 requires adoption of the use of ultra-low sulfur diesel fuel as defined in an industry and the State of Alaska agreement or in new federal regulations. This provision, however, has been superseded, so all potential air quality impacts from site-specific development activities would be limited based on air quality permits issued by the Alaska Department of Environmental Quality and EPA, including applicable control technologies.

Consistent with 40 CFR Part 69, beginning on December 1, 2010, the diesel fuel that is designated for use in rural Alaska for all on-road and non-road vehicles and equipment, locomotive, and marine, will be ultra-low sulfur diesel fuel (15 parts per million sulfur). Ultra-low sulfur diesel became designated for use for on-road vehicles in urban Alaska on October 15, 2006; for non-road vehicles and equipment on December 1, 2010; and will be designated for locomotive and marine vehicles on December 1, 2012. Urban Alaska is those geographical areas of Alaska designated by the State of Alaska as being accessible by the Federal Aid Highway System. Areas not accessible by the Federal Aid Highway System are rural (Elson 2011).

As trace constituents in diesel fuel, sulfur compounds may cause adverse air quality impacts through formation of sulfate particulate matter (affecting visibility) and deposition of acidic aerosols. These impacts would be reduced significantly by utilizing ultra-low sulfur diesel fuel. In addition, ultra-low sulfur diesel fuels burn cleaner and produce less light absorbing carbon particulate matter (soot, also called black carbon). When burned, ultra-low sulfur diesel emissions are much lower than those generated by previous fuels, reducing fine particulate (soot), sulfuric acid, and sulfate (visibility) impacts.

4.3.1.4 Conclusion

Emissions and resulting air quality impacts from Alternative A are expected to be lower than Alternatives C and D due to less federally owned subsurface being available for oil and gas leasing, and higher than Alternatives B-1 and B-2 due to more federally owned subsurface being available for oil and gas leasing.

4.3.2 Paleontological Resources

For a discussion of paleontological resources in the NPR-A see section 3.2.7 in Volume 1.

4.3.2.1 Activities Not Associated With Oil and Gas Exploration and Development

Under all alternatives, paleontological research and excavation could be conducted annually by permit within the NPR-A. There is no direct correlation between the area open to exploration in the various alternatives and the amount of non-oil- and gas-related fieldwork that might be undertaken. While excavation is a destructive activity, it is often necessary for the recovery of scientific data. Planned excavation and collection activities normally occur during the summer, and are typically the result of paleontological and geological research; however, on occasion, paleontological material has been inadvertently discovered as a result of archaeological research. Other than Pleistocene-age fossils, most paleontological material is buried considerably deeper than archaeological material and is therefore, not regularly encountered by chance. Some Pleistocene-age animal remains can be expected to occur in archaeological deposits if the deposits are old enough. In those situations, the remains would probably represent subsistence use of the animal(s) by humans. In such a case, the faunal material would be considered part of the archaeological record as well as the regional paleontological record.

Aircraft and watercraft traffic, summer camps, hazardous and solid waste material removal and remediation, overland moves, and recreation associated with non-oil and gas activities could potentially have effects on paleontological resources although past experience indicates that it would be minimal if it did occur. While it is unlikely that aircraft and watercraft use would have a direct effect on paleontological resources, they could have an indirect effect by making paleontological resources more accessible to recreation and other users, which could lead to unauthorized collecting and inadvertent damage.

The temporary summer field camps commonly associated with scientific or resource assessment work, guided hunting, and river float trips generally create, if any, low level impact within relatively small areas. Therefore, such camps and the activities associated with them, such as aircraft use, on-the-ground survey and reconnaissance, hazardous and solid-waste material removal, site remediation, and recreation potentially would have only a minor effect on paleontological resources.

4.3.2.2 Oil and Gas Exploration and Development Activities

Seismic Surveys

Seismic surveys normally precede exploratory drilling for oil and gas and are almost universally conducted during the winter on the North Slope when frost and snow depth are sufficient to protect the tundra. In most cases, these conditions would also protect any undiscovered surface/near-surface paleontological materials that might be present on seismic lines or camp locations. Currently, the vibroseis method is almost universally employed for terrestrial seismic data collection, and rarely causes any significant disturbance to the ground surface or subsurface. Because the lines of a 3-D seismic program within a given area are closer together, there are more of them than there would be for a 2-D program in the same area, the potential for impact is slightly higher from a 3-D program.

Under Alternative A, seismic surveys could involve approximately 56,600 survey and camp train miles and 538,000 survey and camp train acres. Given the conditions under which most North Slope seismic surveys are conducted and the methodology employed, there is almost no chance that buried paleontological material would be impacted and only a low probability that undiscovered surface/near-surface material would be impacted, except in areas where there is a high density of paleontological remains. Overall, the probability of encountering scientifically significant paleontological material is low. It should be noted that as the area of potential impact becomes larger with the other alternatives, statistically, the possibility of impact to paleontological resources increases. Nonetheless, overall, the probability of impact to paleontological resources remains low.

Short-term Disturbance: Exploration and Delineation Drilling

The drilling of exploration and delineation wells would typically occur during winter. Under Alternative A, it is estimated that during the exploration/delineation phase as many as 326,684 acres could have ice and snow infrastructure constructed upon the surface. However, because of the construction method, no significant ground disturbance is anticipated, and it would be unlikely that any buried paleontological material would be impacted. Depending upon the location of a given drill pad, road, or airstrip, it is remotely possible that previously undiscovered surface/near-surface paleontological material could be encountered and impacted. Some surface/near-surface disturbance will occur at each well's cellar box location, encompassing an area of approximately 64 square feet. This constitutes a potential total of slightly less than a third of an acre of surface/near-surface disturbance if the anticipated maximum number of wells is drilled. The only substantial subsurface disturbance would occur as a result of drilling the borehole itself. If paleontological materials are present at the site of a borehole, those materials could be adversely impacted by the drilling process. However, the likelihood of borehole drilling encountering and impacting scientifically significant paleontological material is very low.

Long-term Disturbance: Development of Oil and Gas Infrastructure

Under Alternative A, surface/near-surface disturbance from construction activities could impact as much as 9,902 acres. Impact to paleontological resources from this type of activity can occur in a variety of ways and levels of severity. The primary potential impact to paleontological resources would result from the excavation of mineral material (gravel) needed for construction of the long-term oilfield facilities. Both Pleistocene and Tertiary age vertebrate fossils may be encountered during gravel-mining operations within the NPR-A. Pleistocene-age remains are by far the most common. While it is anticipated that a surface area of 1,415 acres (2.2 square miles) would be impacted by the establishment of up to 40 material sources (borrow pits). Impact to the surface/near-surface zone is only a minor aspect of the potential overall impact. It is the volume (cubic yards) of mineral material removed from the pits that constitutes the greatest potential impact to paleontological resources. As the amount of mineral material excavated increases, the probability that paleontological remains will be encountered and adversely impacted, also increases. This is because mineral material of the type required for pad/road/airstrip construction generally accumulates in unconsolidated deposits that incorporate a variety of other materials such as plant and animal remains. Under Alternative A, as much as 40 million cubic yards of mineral material could be excavated from borrow pit localities scattered around the areas of hydrocarbon accumulation within the NPR-A. Past gravel mining activities on the North

Slope have regularly encountered paleontological material, and it would be expected that such would be the case under the Alternative A scenario. Additionally, when mineral material is laid down in the construction of pads, airstrips, and roads, it is possible that undiscovered surface/near-surface paleontological material could be impacted if present.

It is anticipated that in all but exceptional circumstances, oil pipelines will be elevated above the ground, constructed during the winter months from ice roads/pads, and will not have associated all-season roads or pads other than at production facilities. Therefore, the potential impact to paleontological resources resulting from oil pipeline construction would be limited to the laying down of ice roads/pads (previously addressed) and the placement of vertical support members. Depending on the depth at which the vertical support members are set, it is possible, though unlikely, that buried paleontological resources could be impacted. However, the process of drilling holes to set vertical support members will impact the surface/near-surface zone. Under Alternative A, a maximum of 818 miles of oil and feeder pipeline could be constructed. It is estimated that there would be 81 vertical support members per mile, for a total of 66,258 vertical support members. Drilling a single vertical support member borehole would impact approximately 4 square feet of the surface/near-surface zone. For 818 miles of pipeline, the total area impacted would be about 6 acres. Because the vertical support member borehole alignments comprise transects across the landscape, the chances of encountering and impacting paleontological material are raised considerably when compared to the probability of occurrence within a single 6-acre plot. If the natural gas pipelines were also placed on vertical support members, then the number of boreholes would be roughly doubled and the probability of encountering/impacting paleontological material would increase accordingly. Nonetheless, the likelihood of encountering and impacting any scientifically significant paleontological material, generally, remains low.

While it is possible that gas pipelines would be elevated on vertical support members, it is more likely that they would be buried. Under Alternative A, this would assume that up to 800 miles of trench approximately 5 feet deep and 4 feet wide would be excavated, moving 3.2 million cubic yards of mineral material and impacting 387 acres of surface/near-surface area. There would also be an area of associated surface/near-surface disturbance 5½ feet wide, bordering each side of the trench, totaling 1,066 acres. Excavation increases the probability that paleontological materials might be encountered and impacted, and the fact that the excavations are transects across large segments of landscape increases the possibility to a greater degree.

The most important factor in regard to the probability of adversely affecting paleontological resources in regard to oil and gas exploration and development activities in the NPR-A is the geographic location of a given activity. Other than in a very general sense, it is difficult to assume the location of future oilfield infrastructure, and therefore, the areas where impacts might occur. Previous reconnaissance, survey, and excavation/collection have shown that some areas within the NPR-A have a higher potential for containing paleontological resources than others. The areas of highest probability for economically recoverable oil and gas include areas known to have a relatively high density of paleontological material. This is especially true of the Ikpikpuk, Titaluk, Kikiakrorak, Kogosukruk, and Colville drainages.

Effects of Oil Spills and Gas Releases

If there were a catastrophic terrestrial oil or gas well blowout in an area where surface/near-surface paleontological resources were present, the resources would probably be destroyed or rendered scientifically valueless, by either the blowout or the subsequent cleanup and remediation procedures that would follow. Large-volume spills are also a very low probability event, and if one occurred, the impact to surface/near-surface paleontological material could be similar to those associated with a blowout. A large-scale gas release would probably have little effect upon paleontological resources, depending upon the degree of invasiveness of the cleanup and remediation actions. Otherwise, an estimated 65 to 80 percent of all oil spills are confined to a pad, with the remainder generally confined to an area adjacent to the pad. During exploration, it is assumed that most spills would occur on an ice pad, ice road, or frozen landscape, resulting in cleanup that is less invasive than the cleanup required by a spill on the landscape during summer. The majority of paleontological resources are buried deeply enough so they would not be affected by either a spill or subsequent spill cleanup. The effects of spills and spill cleanup associated with development would be similar to those associated with exploration activities, except that they could occur during the snow-free months. Although cleanup from the spills could be more invasive because the ground surface would not be frozen, there is little chance that buried paleontological resources would be impacted. However, if present, surface/near-surface paleontological material could be impacted, especially if the material is of Pleistocene age, as it could not be accurately dated due to oil contamination. A gas release would probably have little effect on paleontological resources. Nonetheless, since the occurrence of scientifically significant paleontological remains is uncommon, the probability of encountering and impacting noteworthy material is relatively low.

Effects of Abandonment and Reclamation

Under most circumstances, abandonment and reclamation of infrastructure would have limited, if any, impact on paleontological resources. This assumption arises from the fact that any impacts to paleontological resources at the site being rehabilitated occurred during the development and/or operation of the site. If previously unimpacted areas are encompassed by the abandonment and reclamation activities, which would seem counterproductive to the desired end result, then it is possible that impacts to undiscovered surface/near-surface paleontological material could occur. Nonetheless, the probability of encountering scientifically significant material remains quite low.

4.3.2.3 Effectiveness of Stipulations and Required Operating Procedures

Under Alternative A, the primary safeguard for paleontological resources is Required Operating Procedure E-13, which states that lessees will conduct a paleontological resources survey prior to engaging in any potential ground-disturbing activity. Most aspects of oil and gas exploration and development activities fall into this category, including all types of drilling; construction of ice roads, pads, and airstrips; and all development-phase construction. The required paleontological surveys are primarily surface reconnaissance of the areas where the permitted activities are to take place and are generally centered on examination of unvegetated locales (if any are present) where organic and mineral soil is exposed. In areas where paleontological material is known or believed to be present, greater scrutiny is employed, particularly at locations where excavation will occur, such as borehole drilling, trenching, and mineral material extraction. Additional protection is provided by Required Operating Procedure C-2, which affords protection to streambanks, minimizes soil compaction, and impacts to the surface and near-surface of the landscape. Also contributing to the protection of paleontological resources is Required Operating Procedure I-1, which requires that all personnel involved in oil- and gas-related activities be made aware of environmental concerns that relate to the region/work site. Additional protection that applies in select biologically sensitive areas also provides protection for paleontological resources in that the flood plains, terraces, and banks of specific rivers known to contain paleontological material are safeguarded by construction setbacks. Contributing to this protection are the inventorying and monitoring conducted in the NPR-A by the BLM, other agencies, and permittees over the last two decades.

If paleontological materials are known to be present in an area where they will be impacted by planned oil and gas exploration or development activities, a mitigation procedure concomitant with the scientific significance/value of the material will be determined by the BLM. If previously undiscovered paleontological material is encountered during oil and gas exploration or development activities, the activity will cease, the BLM will be notified and will evaluate the situation and determine an appropriate mitigative procedure before the activity can recommence.

4.3.2.4 Conclusion

Other than Pleistocene remains, most vertebrate paleontological material is deeply buried, and is therefore, not regularly encountered by chance. The drilling of exploration and delineation wells would occur during winter, and these activities potentially could have an impact on paleontological resources. The primary impact to paleontological resources would result from the excavation of gravel for construction of the permanent facilities. However, surveys for paleontological resources are required to be conducted before excavation or any potential ground-disturbing activities could take place. Given the effectiveness of the protection and the distribution, density, and context of paleontological resources, both non-oil and oil-related activities within the NPR-A have a very low probability of impacting paleontological resources. Indeed, the potential effects of climate change on cultural resources (described in section 3.4.2.2 in Volume 1) could be greater than the potential impacts associated with Alternative A.

4.3.3 Soil Resources

4.3.3.1 Activities Not Associated with Oil and Gas Exploration and Development

Ground-impacting management actions within the NPR-A that could affect soils under Alternative A include aircraft use (landing and takeoff), use of off-highway vehicles such as snow machines and four-wheelers, and other ground-disturbing activities.

Where activities did not alter vegetative cover, there would generally be only a small impact on soils. However, where these activities concentrate surface disturbance (e.g., foot traffic around a landing site, popular boat launch, wakes from boat traffic, or repeated snow machine crossing of a drainage channel at the same site), there could be damage to the soils. Vegetative cover is critical to protecting soil properties, particularly providing insulation in areas of permafrost. If the vegetative cover or surface organic mat was removed or disturbed, soil erosion or thawing of the permafrost may result in creation of depressions (thermokarst) and total loss of soil productivity. With only weakly developed soil horizons, any disturbance may result in loss of its ability to support the current vegetative cover that protects it and prevents erosion. Upon removal of the organic mat, soils could be deposited into sensitive areas. Sediments are constantly transported by wind and water and then deposited on top of existing soils. Activities that accelerate these processes may be detrimental to the soils by changing the albedo of the surface, thus warming the soil more rapidly. Excessive deposition may also alter the plant communities, which thrive in particular locations.

Soils naturally thaw during the warm months, resulting in an "active layer" that ranges in depth from 8 inches in poorly drained sites to 80 inches in well-drained inland gravel sites (National Research Council 2003). Variation is based on location, aspect, vegetation type, soil makeup, and amount of contained water. Generally, the loss of vegetative cover would cause the greatest change in the thermal balance. However, compaction of the organic layer could also change the thermal balance by reducing its insulating capacity. Soils containing ice could lose volume when thawing, resulting in subsidence, thermokarsting, and gullying.

Impacts from soil excavation and removal activities would be localized and probably not widely distributed. For soils containing large amounts of ice, however, the impacts would be greater. When warmed, ice-rich permafrost soils could slump and release melted water, creating ponds. Ponded water absorbs more radiant energy and increases the area of warming soils. This form of disturbance would continue well beyond the initial disturbance and take several years to decades to stabilize. However, the landscape can be altered permanently.

Archaeological and paleontological digs could impact soils, but would probably be limited to relatively small areas. Most digs would result in the destruction of soil structure at the site. Overall, the extent of these activities would be spread out over several locations and likely impact only a few (4 to 6) acres in the NPR-A per year.

Camps associated with scientific studies, recreational use, and other activities (including film permits) could result in compaction of soils from foot traffic and tent placement, and in small spills of stove or generator fuel. These impacts would typically be long lasting and could result in small areas of subsidence. Recreational camps are often located on river bars where soils are more resilient. It is likely that larger camps would be located on existing gravel pads, which are not likely to show additional effects. The total land surface impacted by all camps is expected to be small (less than 10 acres), and the sites would be scattered.

Off-runway landings by private or commercial wheeled aircraft could cause short-term damage to soils on the landing sites. However, most wheeled aircraft landings would occur on sand or gravel bars, or possibly on dry gravelly ridges. Impacts from such landings should be minor and sporadic in occurrence.

Overland moves occurring in the NPR-A typically involve traffic between existing staging areas at Deadhorse and Barrow. Moves would occur during winter when the ground is frozen and covered with snow. Impacts to soils associated with transport vehicles depend on the type of vehicle, the soil type, and the snow conditions. In general, low-ground-pressure wheeled vehicles have less impact than do tracked vehicles or sleds on skids. In wetter tundra areas, impacts are usually limited to "green" trails caused by compression of snow and dead plant material, where standing dead vegetation has been laid down, leaving only newer, greener vegetation standing in the following summer. Such trails are often visible for one to several growing seasons as the insulation has been preserved and the active layer remains at pre-operations depths. In general, wet areas may freeze deeper and be less affected than dry areas (Walker 1996), and snow acts as a buffer against these impacts.

Overall, vehicle tracks may affect vegetation, soil chemistry, soil invertebrates, soil thaw characteristics, and cause small-scale hydrologic changes (Kevan et al. 1995). Avoidance of areas with low snow cover, use of low-ground-pressure vehicles, dispersed traffic patterns, and minimized sharp turns could help minimize damage. However, tracked vehicles can disrupt the vegetation surface (insulating layer) when making tight turns or by dropping the vehicle's blade too deeply into the snow, which can result in changes in the active layer and the permafrost. In wet tundra, this disruption can result in water accumulation and thermokarst. In drier tundra, travel over low shrubs can cause breakage and tussocks may be broken or crushed. Trails across the NPR-A are generally about 12–16 feet wide and will impact about 1.5–2.0 acres per mile of trail. A trail from the Colville River to Barrow would be about 100 miles and affect about 150–200 acres. Severity of impacts would depend upon the actual location and type of habitat, but impacts could range from temporary to longer term.

Clean-up activities at former defense sites such as the Short Range Radar Site at Wainwright, could occur at any time of the year and may total three to five clean-up operations throughout the NPR-A. Any such activities that extend beyond the gravel pads would more likely take place during winter and could have impacts to soils similar to those of overland moves, above, with the exception of excavations which, if necessary, would result in complete destruction of the soil profile. In the latter case, a site rehabilitation plan would be developed and implemented, with requirements depending on the local substrate and size of the excavation.

The use of off-highway vehicles, such as four-wheel vehicles and snowmachines, could cause localized impacts to tundra. Use of snowmachines during the winter, when the ground is frozen and there is adequate snow cover, would have little or no impact to the soils. The use of snowmachines during fall or spring, or in areas without adequate snow cover, especially when crossing streambanks, could result in damage to soils, leading to thermokarsting. Similarly, use of four-wheel vehicles on tundra could damage the vegetative mat or churn soil in the upper portion of the profile, leading to braided trails and thermokarst in wet tundra. Even single-pass tracks of off-highway vehicles can leave scars for 50 years or more.

4.3.3.2 Oil and Gas Exploration and Development Activities

The following analysis is based on section 4.2.1.2, "Oil and Gas Exploration and Development Activities." See that section for a discussion of estimates and assumptions for development as well as a description of how estimated areas of disturbance were calculated for each alternative.

During oil and gas exploration and development, various activities could cause impacts to soil in the NPR-A. These activities include seismic activities; construction and use of gravel pads, gravel roads, gravel airstrips, and pipelines; excavation of material sites; and construction of ice roads and ice pads. Impacts could also occur from oil spills and from removal of gravel pads and gravel roads during reclamation. These activities would impact soil productivity and could alter the moisture regime of tundra near the structure by changing natural drainage patterns and areas where snow accumulates. In most cases, the location, magnitude, and total area of affected soils vary by alternative. However, types of impacts to soil from oil and gas activities under all alternatives are similar.

Embankments, such as work and camp pads, roads, and pump stations made from sand, gravel, or rock fragments, completely cover the natural soils and can cause their compaction. Landscape scarring resulting from working material sites, conventional pipeline construction, digging, excavation, and placement of fill is particularly damaging in the Arctic because of the slow rate of pedogenesis (soil formation). Soils in the planning area are subjected to cold and anoxic conditions that retard pedogenesis, allowing exposed mineral soil layers to persist for decades. In addition, any disturbance that removes the insulating surface organic layer or decreases the solar reflectance of the surface may result in differential thawing of the permafrost and cause thermokarst, subsidence, gullying, and increased potential for soil erosion and sedimentation.

Effects of Disturbance

Seismic Surveys

Seismic surveys to collect geological data would occur during the winter months. Frozen ground and sufficient snow cover, along with the requirement for low-pressure ground vehicles, would prevent most disturbances to vegetation or compaction of the soils. A majority of seismic surveys create minor, short-term disturbance to soils and vegetation (Jorgenson et al. 2003). However, even with protective measures in place, some small areas of disturbance to soils and vegetation would be expected to occur from seismic surveys and overland moves. In some instances, past overland moves and seismic surveys have disturbed vegetation (the insulating layer), altered the thermal balance, and increased the risk of thermokarsting (Jorgenson et al. 1996). Areas of soil disturbance could be caused at streambank crossings from damage to the vegetative mat, which could be scraped away, leaving exposed soil. Disturbance could also be caused, damaging the tops of tussocks in dryer areas, reducing the insulating abilities, and hastening loss of permafrost. Water-saturated areas show less damage to vegetation and soils from large-tired vehicles (USDOI 2005). The potential for soil erosion would increase with an increase in disturbance to soil and vegetation. Best management practices and other measures are designed to keep areas and severity of disturbance as small as possible.

The following analysis quantifies the potential impact of one anticipated 2-D survey and 10 anticipated 3-D surveys over the next 30 years. If advances in seismic survey technology make resurveying of already-surveyed lands attractive, additional surveying could occur and add an undetermined amount of impacts. Two-D surveys are most likely in the foothills area.

It is reasonably foreseeable that Alternative A would result in one 3-D seismic survey in the first 10 years. It is foreseeable that four seismic surveys, one 2-D (approximately 500 linear miles) and three 3-D (one approximately 900 square miles each and the others at about 400 square miles each), could occur from 10–20 years. Producing fields would likely have repeated 3-D surveys to enhance recovery after 10 years of production (i.e., 10–30 years from plan implementation). These reshoots would amount to an additional four surveys at about 400 square miles each. Gas discoveries would likely be preceded by another two 3-D surveys at about 400 square miles each. Therefore, it is foreseeable, and assumed in this analysis, that there would be 11 seismic surveys acquired in the NPR-A under Alternative A over a 30-year period.

Seismic surveys to collect geological data and exploration drilling activities would occur during the winter months. Seismic exploration would cause impacts to soils similar to those described previously for overland moves. Two-D survey lines vary in length, but for this analysis, it is assumed a total of 500 miles of 2-D seismic data will be acquired in a single operation, with current technology, within a 900-square mile area. The maximum area impacted by seismic lines would be approximately 12,121 acres (500 miles by 200 feet wide). This acreage is presented as a maximum because not all of the area within the 200-foot-wide path would be overrun by a vehicle. Trails would also be made by camp move vehicles, which would traverse about the same distance as line miles surveyed (Emers and Jorgenson 1997). Additional trails would be made while traveling to or from the survey area. For this analysis, it is assumed there will be six camp strings, each with five ski-mounted trailers, traversing a total of 523 miles. A camp move trail is about 12 feet wide. All trailer strings could use the same trail, but the resulting damage to soils would be more severe initially and longer lasting than if separate trails were used by each trailer string. This analysis assumes that six individual camp string trains would use different trails spread out over a 100-foot-wide area, resulting in less initial damage but a larger area of impact. Additional thermokarst may result over time from this dispersed use. With this scenario, camp moves would potentially impact 6,339 acres (523 miles by 100 feet wide). This survey work would be accomplished over a single winter, and would occur sometime in the first 10 years of plan implementation.

It is assumed that one 3-D seismic operation would cover a total of 900 square miles, and the nine other 3-D seismic operations would cover a total area of 400 square miles (256,000 acres) each. Three-D seismic surveying would have the potential to cause greater impacts to soil than 2-D seismic surveys since tighter turns by heavy equipment are required and have greater potential to disturb soils and vegetation. Each 3-D survey involves a grid pattern of source and receiver lines, with source lines being less than 50 feet wide and receiver lines being about 100 feet wide. Source lines would be spaced about 1,500 feet apart and receiver lines about 1,100 feet apart. For each square mile surveyed, about 17 percent of the survey area would be impacted. The maximum area affected by survey lines for the 10 3-D surveys would be 496,125 acres. For 3-D surveys, the length of camp move trails would be less than those covered by 2-D surveys since a single move would occur down the center of the surveyed area. Camp move trails would impact about 23,467 acres of soils for the 10 surveys. The combination of surveying and camp moves for the 10 3-D surveys would affect a maximum of 519,592 acres. When added to the acres disturbed by the single 2-D survey, a maximum of 538,052 acres would be affected in the NPR-A over 30 years (2.4 percent of the 22.8 million-acre NPR-A). This figure is presented as a maximum, because not all of the area within a path would be overrun by a vehicle and because source and receiver lines would overlap in some areas.

A majority of seismic surveys create minor, short-term disturbance to soils and vegetation. However, some studies on the effects of past seismic activities have shown a small percentage results in moderate to high, long-term impacts (Jorgenson et al. 1996, Jorgenson et al. 2003). The later study suggests that improvements in the equipment and procedures used for seismic surveys have reduced the amount of impact to tundra, resulting in a higher percentage of tundra in categories of minor or little to no impacts and few if any highly impacted sites. Calculations of area impacted by seismic operations in this analysis use a maximum estimated area of disturbance, but it should be noted that the projected impacts are probably greater than actual impacts would be. See section 4.3.5.2 under the vegetation section for a more thorough analysis of potential impacts to vegetation (and therefore, potentially, soils) from seismic surveys.

Exploration

Under all alternatives, permanent or gravel oil and gas facilities including roads would not be constructed during the exploration phase of oil and gas development. Limiting exploration activities to the winter season when the ground is frozen would prevent most damage to soils. However, the construction of ice pads for drilling exploratory or delineation wells and ice roads for accessing the pads could impact soils in the NPR-A. Soil compaction resulting from on-road vehicle traffic could increase localized ponding and permafrost degradation. Degradation of permafrost beneath heated infrastructure would initiate or exacerbate any impacts to the structural integrity of the overlying improvements, so industry would likely attempt to minimize this loss.

In general, ice road and ice pad construction would have only localized impacts on soils, which would usually be limited to compression of the tundra under the ice roads and ice pads. In addition, a recent BLM study of ice road impacts found that the wetter the area (evaluated during summer), the less damage to insulating vegetation and soils from large-tired vehicles (USDOI 2005). Recovery from most minor impacts to vegetation would be expected within a few years. Under Alternative A, it is assumed there would be a total of 196 ice pads built for exploration and delineation wells. At 6 acres per pad, these would have short-term impacts on 1,176 acres of tundra, spread out over 30 years. It is also assumed that there would be 77,340 miles of some combination of ice roads, snow-packed trails (4.24 acres per mile), and ice airstrips (5,000 feet each) constructed throughout the NPR-A over a 30-year period. The total short-term disturbance from these would be 325,508 acres. Since vegetation recovery from these impacts is expected within a few years (Yokel et al. 2007), long-term disturbance from ice pads, ice roads, ice airstrips, and snow trails would be negligible to the health of the soils and proper functioning of the landscape. Although some evidence of crushed tussocks may still be apparent, new growth would preclude any exposed soils or extensive changes in the active layer.

The construction of well cellars during exploration occurs most often in the winter and requires the digging of a hole that destroys soils on approximately 64 square feet (0.0015 acre) of ground, which replaces that soil with bare soil mostly consisting of the parent material. Thermokarst associated with the disruption of the thermal regime in the surrounding soil may also change the soil productivity and hydrologic properties around the well collar to a wetter regime. These impacts could result in 0.3 acre of soil being destroyed under Alternative A, assuming construction of 196 well cellars.

Multi-year ice pads could be used in a second winter, but would require insulation to prevent melting during the spring and summer. Some melting would likely occur around the perimeter of the pad, causing vegetation in this area to break dormancy. If plants breaking dormancy were covered by an insulating layer or by timbers or other material used to hold the ice pads insulating cover in place, they would die from the lack of sunlight (Noel and Pollard 1996, Hazen 1997, McKendrick 2000), thus raising the potential for soil erosion or deepening of the active layer.

Development and Production

During oil and gas development and production, various activities could cause impacts to soils in the NPR-A. These activities include construction of gravel pads, roads, airstrips, and pipelines, excavation of material sites, and construction of ice roads. Impacts of ice roads were discussed previously under the "Exploration" subheading on page 107.

Placement of Gravel Fill

Under all alternatives, construction of central processing facilities and associated satellite pads, roads, pump station, staging bases, and airstrips would result in the loss of soil productivity for many decades to a century or more in areas where gravel was placed. Placement of gravel fill directly on the tundra surface would decrease the porosity and permeability of the underlying soil. Development of this infrastructure for 12 central processing facilities (oil), 27 central gas facilities (gas) and associated satellite pads (16 oil; 60 gas), 38 gravel runways (5,000 feet each = 36 miles) and in-field roads (701 miles) would be developed. In addition to these, it is assumed under Alternative A that two booster pump stations (oil) would be built on 5-acre gravel pads, and four staging bases would be built, covering 50 acres each. All gravel placements taken together would total 7,074 acres of soil productivity lost.

The material used for gravel fill could also impact soil near gravel structures. Saline material used as fill increases the salinity of water draining off of or leaching through the structure. Increased salinity at a site could alter the soil properties in the immediate vicinity of the gravel structure, shifting the soil chemistry in favor of a vegetative community comprised of species that are more tolerant of saline conditions (McKendrick 2000). Such a shift may alter the soil hydrology and insulation, resulting in thermokarst and long-term (100 + years) loss of soils.

Construction of gravel pads, roads, and airstrips could also result in indirect effects to soils by altering the moisture regime of tundra near the structure due to changing natural drainage patterns and areas where snow accumulates. Snowdrifts caused by gravel structures would increase the soil surface temperature in winter and increase thaw depth in the soil near the structures. Blockage of natural drainage patterns can lead to the formation of impoundments. In the Prudhoe Bay oil field, impoundments covered 22 percent of a highly developed portion of the oil field and 3 percent of a broader portion of the oil field (Walker et al. 1987a). Impoundments, which would generally be confined to areas of wet and aquatic vegetation, could alter both the hydrology and species composition of wetlands. Soil productivity could increase biomass of a few species; or productivity may decrease, as a result of loss of plant communities to the development of deep, open water areas. In most cases, impoundments would lead to a decrease in plant species richness (Klinger et al. 1983; Walker et al. 1987a, b). The use of adequate cross-drainage structures in gravel roads and attention to the natural drainage patterns during design of developments could help reduce impacts to soils from impoundments.

The passage of vehicle traffic over gravel pads and roads would result in dust and gravel being sprayed over areas within about 30 feet of the pad or road, and a noticeable dust shadow out to 150 feet or more. Within 30 feet of gravel structures, the dust and gravel could affect the soil-forming processes by altering soil moisture, temperature, chemical reactions, and nutrient regimes within the soil. In extreme instances, this deposition may bury the existing organic horizon of the soil with a new layer of higher bulk density that would restart the soil-forming processes (Everett 1980; Walker and Everett 1987; Auerbach et al. 1997). Alternative A assumes a total of 701 miles of in-field gravel roads and 36 miles of airstrips with a potential for a total perimeter of 1,474 miles. Within 30 feet of gravel fill, up to 5,360 acres could be subject to aeolian transport (smothering) by dust and gravel, and another 21,440 acres could be affected by a dust shadow (darkening of the surface) out to 150 feet from the gravel area.

The effects of dust may include early snowmelt, reduced soil nutrient concentrations, lower moisture, an altered soil organic horizon, and higher bulk density and depth of thaw (Everett 1980; Walker and Everett 1987; Auerbach et al. 1997). Gravel pads, roads, and airstrips would also increase the solar heating during the summer, which will further increase thaw depths, particularly along the south and west sides of the installations. These impacts would be exacerbated by dust deposition and by the formation of impoundments. These factors could combine to warm the soil, deepen thaw, and cause thermokarst adjacent to roads and other gravel structures (National Research Council 2003, page 95). In flat, thaw-lake plains on the North Slope, gravel construction can be anticipated to result in upslope water impoundment and thermokarst erosion equivalent to the area directly covered by gravel (Walker et al. 1987). In general, most changes in the soil structure and chemistry around gravel structures would occur within 164 feet of the structure (Woodward-Clyde Consultants 1983). If all effects were to occur within this zone, a maximum of 29,301 acres would be impacted under Alternative A. Note that this area includes the 26,800 acres affected by dust discussed above, and is not in addition to it. It is presented as a maximum because not 100 percent of the area within 164 feet of roads and airstrips would be affected.

Material Sites

Under all alternatives, gravel required for development in the planning area could be mined from existing sites east of the NPR-A, or could be extracted from new sites developed within the planning area. Investigations to identify gravel sources in the NPR-A have not been conducted for undiscovered oil and gas, but presumably would be initiated if discoveries of recoverable oil and gas were made. Under Alternative A, it is assumed that up to 40 material sites, affecting a total of 1,415 acres, would be needed. Excavation of the gravel mine and stockpiling of "overburden" would require removal of overlying soils and create long-term impacts to soil productivity at gravel-extraction sites. Stockpiling of overburden mixes organic and mineral horizons with the parent material from below, which destroys all soil development and may require several hundred years to redevelop.

Pipelines

Oil pipelines on the North Slope are typically built on vertical support members with a diameter of 12 inches and a spacing of 80–150 vertical support members per mile. In addition to the soil displaced by the vertical support member, installation of vertical support members disturbs a zone around the vertical support member that is approximately 20 inches wide. This zone of disturbance results from spoil material deposited around the vertical support members and from thermokarst, which may result in a change in soil type around the vertical support members. Approximately 0.05 acre of soil would be disturbed per pipeline mile for gathering lines, and 0.03 acre per mile of regional lines. Under Alternative A, 224 miles of gathering lines and 594 miles of regional oil pipelines would disturb 29 acres of soil through vertical support member placement. Ice roads built for construction of these pipelines would have only short-term impacts to soils, as described above for exploration activities, and would affect 3,468 acres. In reality, some of the vertical support members for gathering lines would be over gravel pads and would have no additional impact on soils, nor would ice roads be necessary for construction of these portions of pipeline.

Pipelines could also impact soils indirectly by altering snow accumulation patterns and by shading vegetation, which may decrease soil temperatures and could potentially affect plant growth. Pullman and Lawhead (2002) found that most sites under the Alpine and Tarn pipelines did not differ substantially from nearby background areas located upwind. At about 25 percent of the sites sampled, substantially more snow accumulated under the pipeline, and at about 18 percent of the sites, substantially less snow accumulated under the pipeline. In general, the snowpack was most likely to be deeper under pipelines with an east-west orientation, and when pipeline clearance was reduced to below 5 feet.

Soil under a pipeline receives less direct sunlight during the growing season than does the soil that is not under a pipeline. Therefore, there could potentially be a reduction in heat absorption by the ground cover, leading to a shallower active layer. However, there are no data that specifically address these questions.

It is assumed that gas pipelines would be buried. (Short lengths of oil pipelines might also be buried and produce impacts to soils similar to those described here.) It is assumed that a 35-foot ice road would be built for buried pipeline construction. This short-term disturbance for gas gathering lines, regional gas pipelines, and a high-pressure gas pipeline would affect 4,619 acres, and would usually be limited to compression of the tundra under the ice roads and damage to the tops of tussocks in drier soils. Pipeline burial, however, would destroy soils where the trench was constructed (4-foot wide area) and would alter soils in adjacent areas where temporary storage of the overburden occurred (11-foot wide area). The latter two disturbance types would be long-term in nature and would likely include potential soil compaction, thermokarst, and disturbance of the insulating vegetation. The total width of direct plus indirect impacts would be approximately 15 feet. This equates to approximately 1.8 acres of soil disturbance for each mile of buried pipeline. Total long-term impacts from burial of gas-gathering lines, regional gas pipelines, and a high-pressure gas pipeline would be 1,386 acres. Because of the poor soil development and lack of nutrients, colonizing species would have difficulty invading such a wide area, and a recovery time of several years or longer may be expected, though wetter areas would generally revegetate before drier areas (McKendrick 2000).

Soils thus disturbed in the ice-rich northern part of the NPR-A are more likely to experience thermal degradation and subsidence as a result. In this case, the soils would not be lost completely, but soil horizons as well as the thermal regime would be altered. Melting of ice in the soils would result, and the filled area, normally mounded immediately after fill, would level over time as melt water migrates. Ponding, and potentially soil erosion, could occur if the trench surface subsides below the grade of the surrounding terrain over time. These impacts would be dramatically reduced if gas pipelines were put on vertical support members.

Summer Tundra Travel

On a case-by-case basis, the BLM may permit low-ground-pressure vehicles to travel off of gravel pads and roads during periods other than when the ground is frozen and covered with snow. This is expected to be an uncommon occurrence, and if permitted at all, it would likely be only during very early or late summer to fall. Because of restrictions that would be placed on this activity, impacts to soil should be limited to the compression (reduction) of the insulating mat, similar to what happens during winter following traffic by low-ground-pressure vehicles.

Effects of Oil and Gas Development on Permafrost

Under all alternatives, oil and gas activities can have adverse effects to permafrost. Except for the active layer, which lies between the top of the permafrost and the ground surface and thaws each summer, the ground is permanently frozen to about 660–2,130 feet deep on the North Slope (National Research Council 2003). The permafrost contains varying fractions of ice, and this ice supports buildings, roads, or pipelines placed on it. The amount of potential subsidence from thawing permafrost is proportional to the volume of ice contained in the soil. Ice content can vary widely in the NPR-A and is dependent on ice structure, soil texture, and type of terrain (Jorgenson et al. 2003). Thus, structures must be designed to avoid thawing their own foundations. Roadways and buildings must be elevated on thick gravel berms or pads, or on pilings. Gravel berms for roads can be as high as 6 feet above the tundra surface to ensure that the subgrade remains frozen. These roads have visual impacts on the landscape, and can intercept natural drainage and create ponds that thicken the active layer and initiate thermokarst (Walker 1996).

Oil pipelines generally must be built on vertical support members to ensure that the heat from the transmission of warm fluids does not thaw the surrounding permafrost, causing differential settlement. Heated buildings can also thaw the permafrost, leading to thaw settlement, if they are not elevated on pilings or their foundations insulated and refrigerated. On pads with closely spaced wells, extensive refrigeration with passive heat pipes and insulation is required to ensure that the heat from fluids does not melt the permafrost. It is standard industry practice to incorporate designs that minimize or prevent thawing of the permafrost. Under Alternative A, less surface disturbance is expected from oil and gas activities as compared to Alternatives C and D, but more disturbance than under Alternatives B-1 or B-2 (Table 4-14).

Abandonment and Reclamation

During abandonment activities, soils and wetlands would be impacted by dust fallout along roads, by ice roads and other off-road tundra travel associated with dismantling of pipelines and power lines, and by disturbance to soils adjacent to vertical support members and power line poles during their removal. The level of impact from these activities would be roughly the same as that during construction if gravel fill was removed; impacts to the proper function of the overall landscape would be less if the gravel were to be left in place. If roads and pads were left in place, and especially if cross drainage across roads was not maintained, water impoundment would occur, and could alter soil hydrology as described for the construction period. It is also likely that the non-maintained roads would have occasional washouts, where alluvial deposition could occur. Roads and pads, if left in place, would likely need to be revegetated with plants native to gravel bars and ridges in the Arctic (i.e., different from the plant communities surrounding the facilities). Revegetation activities could take several years, as initial attempts are not always successful. Removal of gravel from pads, roads, and airstrips could be mandated. Partial or complete removal of gravel would accelerate thaw subsidence because the insulating vegetation under pads would have been destroyed during construction. However, removal of the gravel would allow the reclamation process to begin, and could result in faster reestablishment of native plant growth, although establishment can take many years (more than a decade). Mixing of substantial quantities of organic matter (peat or other native materials) into a portion of the gravel in sufficient quantity to retain the insulating properties could hasten the rehabilitation without adversely affecting the permafrost. Thaw subsidence is difficult to predict, and complete restoration to preexisting conditions is not likely if it occurs.

Effects of Spills and Gas Releases

Under all alternatives, spills could adversely affect soils in the NPR-A. Spills can create direct toxic effects to soil productivity, and depending on the season, soils can also be impacted by compaction and thermokarst during cleanup activities. A fairly large spill (4,800 barrels) occurred on the North Slope in 2006 and impacted approximately 2 acres of tundra (see section 4.2.2.1, "Oil Spills"). Most Alaskan North Slope spills have been contained on gravel pads and roadbeds (National Research Council 2003), and most of those that have reached the tundra have covered fewer than 5 acres (USDOI BLM and MMS 1998).

If released onto tundra, oil can penetrate the soil as a result of the effects of gravity and capillary action, with the rate of penetration depending on the season, the nature of the soil, and the type of petroleum product. In summer, spills can penetrate the active layer (the layer of soil and rock that thaws each summer and freezes each winter, which overlies the permafrost layer of permanently frozen soil and rock) and then spread laterally on the frozen subsurface, accumulating in local depressions or being carried into open waters at an outfall. From there, the oil can penetrate into the permafrost (Collins et al. 1993). Precipitation may increase penetration into thawed soils/active layer (Solntseva 1998 in Chuvilin et al. 2001). In winter, when the ground and water surfaces are frozen, spreading is affected by the snow cover or frozen soil. Snow cover can act as an absorbent, slowing the spread of oil or preventing the spill from reaching the tundra surface. Therefore, oil tends to spread on the surface of the frozen soil, and penetration of oil into the soil is limited. However, any soil pore space that is not filled with ice may allow spilled oil to move into the frozen soil (Yershov et al. 1997; Chuvilin et al. 2001). See section 4.2.2.1, "Oil Spills" for a more extensive discussion of the fate and behavior of spills.

Upon detection, spills have been promptly contained and cleaned up as required by State, federal, and North Slope Borough regulations (National Research Council 2003). Impacts that have occurred were judged to be minor, and natural and/or anthropogenic-assisted restoration has generally occurred within a few months to years. Approximately 20–35 percent of past crude oil spills have reached areas beyond pads (USDOI BLM 2008). For this analysis, it was assumed that 27 percent of all spills would occur or reach beyond gravel pads. Most spills would happen during the winter and could be cleaned with minimal impacts to soils and vegetation. Plants may assist in phytoremediation of spill effects if they survive the spill. If it is assumed that 60 percent of all spills would occur during the winter, approximately 11 percent of all oil spills would reach soils during the snow-free season and have more than a minimal effect. Under Alternative A, this would mean 58 of the 526 crude and refined oil spills assumed to occur over the life of the plan.

Most oil spills would cover less than 500 square feet (less than 0.01 acre). However, a spill event that includes an aerial pressured discharge can cover substantially more area as occurred at an ARCO drill site in 1993 when just 1 to 4 barrels of crude oil misted over an estimated 100 to 145 acres (Ott 1997). (Such a spill is a very low probability event, occurring less than once out of the total spills expected throughout the life of this plan. Thus, its magnitude is not apparent in the following acreages). Assuming the average spill would cover 0.1 acre, under Alternative Approximately 6 acres would be impacted substantially during the lifetime of development in the NPR-A.

If seawater were used for enhancement of oil production, a saltwater spill could occur within the planning area. According to McKendrick (2000), brine spills kill plants on contact, which could increase erosion potential and also may increase soil salinity to the point that many species cannot survive. Unlike oil, salts are not biodegradable, and natural recovery occurs only after salts have leached from the soil. A saltwater spill would degrade soil productivity and have effects on salt-intolerant vegetation near the seawater pipeline, resulting in small areas of exposed soil. However, the amount of tundra habitat affected would likely be limited to a few acres or less. In the case of a saltwater spill on tundra, the water would likely be adsorbed into the vegetative mat or, in wet habitats, diluted with fresh water.

Under all alternatives, large spills may occur during the life of oil development that might proceed from leasing in the NPR-A. Large spill scenarios involve a 4,800-barrel crude spill from a pipeline or a 900-barrel crude or diesel oil spill from a gravel pad facility (see section 4.2.2.1, "Oil Spills"). For analysis purposes, it is assumed that two pipeline spills will occur under Alternative A, and that three such spills could occur under the other alternatives. A large spill from a planning area facility or pipeline could happen at any time during the year. Under Alternative A, it is expected that the risk of spills in the planning area would be slightly higher than in Alternatives B-1 or B-2 since more oil and gas activity is expected to occur (see Table 4-12 to Table 4-14). Alternatives A and C are somewhat similar, although overall production and activity and infrastructure is higher in Alternative C. Potential impacts to soils from spills would be limited under Alternative A.

A single gas release occurring with ignition could have thermal effects to approximately 194 acres of tundra (500-meter radius). The assumed number of gas releases under Alternative A (2.3 = 762 miles of pipe at a rate of 0.9 incidents per 300 pipe miles), if ignited, would result in thermal effects to approximately 466 acres of tundra. If a wildfire resulted, additional acreage would burn, the amount depending on season, weather conditions, moisture content of vegetation, and suppression effort. Most North Slope tundra fires are less than 1,000 acres (Racine and Jandt 2008). Total vascular plant cover following lightning-caused tundra fires reached 50–100 percent after 5 to 6 years (Racine et al. 1987). Lichens, however, could take several decades to recover if they can achieve former densities at all under a climate-warming regime (Jandt et al. 2008).

4.3.3.3 Effectiveness of Stipulations

To protect soils in the NPR-A, the approval of most proposals for summer operations are limited. Because of the fragile nature of thawed tundra during the summer, permit sites are restricted to durable areas such as gravel bars, beaches, or existing gravel pads. Vehicles allowed for use in overland moves would exert low ground pressure and be permitted to travel only over snow-covered ground frozen to a sufficient depth to minimize impacts to soil and the insulating vegetation. Lease stipulations and required operating procedures described in Table 2–3, if properly implemented, should effectively reduce the impacts of development on the soil profile under Alternative A. Many of the lease stipulations under Alternative A directly or indirectly limit potential impacts to soils in the planning area. Lease stipulations on activities associated with oil and gas exploration (D-1 and D-2) and required operating procedures affecting development (E-4, E-5, E-6), such as facility design and construction of pipelines, roads, drill pads, airstrips, and other facilities, are expected to effectively minimize the amount of habitat that would be altered by gravel pads and other surface disturbances. Lease stipulation G-1 would facilitate the regrowth of native vegetation following facility abandonment to increase insulation and retain permafrost. The setbacks outlined in lease stipulations (K-1, K-2, K-3, and K-11) associated with development near rivers, lakes, and other specified habitats would be effective at minimizing impacts in high-value wetlands and their associated soil plant communities, such as areas dominated by pendant grass and riparian and floodplain habitats. Required Operating Procedure L-1 would minimize the impacts to soils from summer tundra travel, if such an action is permitted.

4.3.3.4 Conclusion

Numerous technological advancements have been made during the decades of operations on the North Slope that have allowed current development activities to proceed with less environmental impact than previous operations (National Research Council 2003). However, some short-term disturbance and permanent long-term impacts to soils are inevitable. Soil stability depends on vegetative cover; where vegetation is disturbed, impacts on soil follow. Impacts to soil from management actions under Alternative A would involve short-term disturbance over fairly large areas and long-term disturbance of relatively small areas. However, all areas of soil disturbance would be small as a percentage of the entire NPR-A. The duration of these impacts could range from one year or less for minor disturbance of soil and vegetation to decades if the soil was destroyed or permafrost thawing (thermokarst) was extensive.

Impacts to soils from oil and gas exploration would occur from seismic work and construction of well cellars during exploratory drilling and the construction of ice roads and ice pads. Based on earlier studies, there should be no substantial, long-term impacts to soils from seismic lines, but camp move trails (overland moves) could substantially impact approximately 1,490 acres after 8 to 9 years. Effects of well cellar construction would also be long-term, but would impact less than 3 acres of soil.

The effects of oil and gas development and operation would include compaction and damage to soil during construction of gravel pads (central processing facilities or central gas facilities, satellite drill pads, pump stations, and staging bases), roads, and airstrips, from excavation of material sites and burial of gas pipelines, and construction of vertical support members. These impacts would be long-term and would impact about 9,902 acres, or 0.04 percent of the 22.8 million-acre NPR-A. Soils could also be altered by dust deposition, salinity of gravel fill used in construction, snowdrifts, and blockage of or change to natural drainage patterns. These impacts would be also be long-term and would impact about 26,800 acres, or 0.12 percent of the NPR-A.

In terms of scale, the overall impact to soils in the planning area would be minor. Although all soil map units identified on Map 3.2.8-1 could be impacted during oil and gas exploration and development, soils associated with map units IQ6, IQ2, and IQ21 (see section 3.2.8, "Soil Resources" in Volume 1) would likely be most affected since they are located in the areas having the highest economic potential for oil and or gas.

Impacts associated with oil spills, the majority of which would be cleaned up immediately, could adversely affect soil resources for a few years to several decades depending on the quantity, location, and season of the spill.

It is assumed that impacts to soil horizons would occur in proportion to their occurrence within the NPR-A. However, precluding development in a large block in the south and west of the NPR-A would protect soils on the steeper lands that are more prone to erosion and where vegetation may be sparse.

As a rule, summer tundra travel would not be permitted under Alternative A. Therefore, only minor impacts to soils in the planning area would be expected as a result of summer tundra travel.

Impacts to soil resources from non-oil and gas activities, and from oil and gas activities, would likely be additive in most cases, except in those areas where the two types of activities overlapped. In these areas, the total actual impact could be less than the sum of both impacts because some of the activity would occur on areas already impacted. Impacts to soil resources from exploration and development activities would also be additive, except where development activities occurred in areas previously disturbed during exploration. In areas where two or more activities occurred, overall impacts would reflect those impacts associated with the first activity and any new impacts associated with later activities. Because of the different exploration and development scenarios for each alternative, the potential for short-term impacts to soil resources in terms of areal extent under Alternative A would be about 39 percent more than Alternative B-1, 29 percent more than Alternative B-2, 26 percent less than Alternative C, and 28 percent less than Alternative D. The potential for long-term impacts to soil resources in terms of areal extent under Alternative

A would be about 32 percent more than Alternative B-1, 18 percent more than Alternative B-2, 30 percent less than Alternative C, and 30 percent less than Alternative D.

Climate change may have several effects on the soil profile over time, exacerbating the loss of permafrost and soil insulation from activities associated with Alternative A. In a warming climate, the depth of the active layer would be expected to increase as we lose some of the permafrost over time. This may result in either ponding of water or excessive drainage from organic soils, depending on the topography and drainage patterns. Warming temperatures may also accelerate the rates of decomposition of organic matter, accelerating the loss of soil insulation. Bacteria and microbial cavities in soils would be expected to increase substantially with rising soil temperatures, which may accelerate the rate of biological soil development and aid in recovery of soils after damage.

4.3.4 Surface and Groundwater Resources and Water Quality

4.3.4.1 Activities Not Associated With Oil and Gas Exploration and Development

Various types of activities not related to oil and gas leasing and development could affect water resources and quality in the NPR-A. Small groups of scientists and recreationists may set up temporary camps for one to several days or remain for weeks for the purpose of photography; observing wildlife; hunting; and excavating fossils, rocks, soil, or vegetation samples. Small groups traveling via boats would likely carry small quantities of stove fuel or gas for boat motors while camps located at established sites like the Inigok airstrip or other accessible landing sites could store larger quantities of aviation fuel in drums or in large bladders. Both aircraft and watercraft have the potential for small (less than five gallons) fuel spills during refueling or spills from leaking fuel containers. Refueling operations of aircraft and watercraft adjacent to local waterbodies could threaten contamination if spill containment and cleanup materials were not available onsite.

Inland and offshore watercraft groundings could pose threats to water quality if spills resulted from the groundings. Severity of the spills would be dependent on the size of the fuel stored on board the watercraft, the amount leaked, and the location where the grounding occurred. Impacts from spills are described in section 4.3.4.2 starting on page 120. An oil spill from offshore state or Outer Continental Shelf oil and gas activities could affect freshwater and estuarine surface water quality. However, offshore oil and gas are not associated with the proposed action alternatives nor are they non-oil and gas activities.

Required operating procedures A-1 through A-7 would regulate garbage, wastewater, drilling wastes, fuel and chemical storage, fuel handling, and require spill prevention and clean-up plans. Impacts from fuel spills, wash and kitchen waters, human waste, and garbage under all alternatives are expected to have no measurable effect on water quality.

4.3.4.2 Activities Associated With Oil and Gas Exploration and Development

Effects of Seismic Surveys

Modern-day seismic equipment has caused minimal impact to the tundra, but camp move vehicles can still cause thermokarst, especially when snow is insufficient to protect soil and vegetation (WesternGeco 2003). Removal or damage of the organic mat exposes soils to erosion by wind and water, which could deposit sediment into waterbodies resulting in higher turbidity and concentrations of suspended sediment. To cause high turbidity, the peat mat must be sufficiently eroded to expose underlying mineral soils, and the mineral soils must be fine grained. Required Operating Procedure C-2 requires ground operations to commence only when frost and snow are at sufficient depths to protect stream banks, and minimize the breakage, abrasion, compaction, or displacement of vegetation and prevent future thermokarst.

Studies of impacts to vegetation from seismic activity are discussed in section 4.3.5.2. It is estimated that a total of 1,490 acres of moderate to high impacts from seismic activities could result from Alternative A and slightly more from all other alternatives. These long-term impacts may result in thermokarst erosion with increased turbidity in local waterbodies.

Effects of Water Withdrawal from Lakes

The primary source of water during the winter months is unfrozen water that lies beneath the ice cover of both shallow and deep lakes. This water is somewhat saline because of the exclusion of ions during the freezing of the upper part of the lake. Water from lakes may be used for ice roads, pads and airstrips, and for drilling and production water and potable water at drilling facilities, but the volume of water taken from an individual lake depends on the depth of the lake, depth of unfrozen water in the lake, and the presence of fish and the type of fish present.

Removal or compaction of snow can increase the depth of freezing on lakes, sometimes by 1 foot or more. As a result, the water quantity available in a lake during the winter months can be greatly reduced, and the salinity of the water beneath the ice can be increased. Required Operating Procedure B-2, which sets forth current water withdrawal requirements to maintain the natural hydrologic regime, prohibits snow compaction on fish-bearing lakes, except at ice road crossings.

At the present level of withdrawals, winter extraction of water or removal of ice chips for road and ice bridge crossings have not resulted in measurable water chemistry changes (Hinzeman et al. 2006). Recharge of water withdrawn from lakes occurs during breakup and may originate from melting ice roads, snowmelt, and inflow from upstream lakes and drainages. During snowmelt, the removed waters would be replaced by less saline, less alkaline runoff water, which would return the lake salinity to normal summer levels. Effects during exploration on water quality from water withdrawals would be short term and minor, returning to normal levels after breakup.

Effects of Ice Roads, Ice Pads and Ice Bridges

Ice roads and ice pads are used extensively during the winter exploration season for access and for exploration drilling and testing. Ice roads require about 1 million to 1.5 million gallons of water per linear mile and generally can be built at a rate of about 1.5 inches of thickness per day (USDOI BLM 1998b). Ice pads can require up to 5 million gallons of water to build and range in size from 3 to 10 acres. An alternative to using water from lakes is to use aggregate ice chips from lakes since a rate up to 4.5 inches of thickness per day can be obtained while building ice roads. It takes less time to build an ice road or pad using the aggregate chips, but these chips require time to collect and transport.

Floating ice bridges may be necessary to cross large rivers and must be of sufficient thickness to handle heavy truck and rig traffic. Construction of an ice road capable of transporting a drilling rig across a river such as the Colville River may be designed to freeze most of the water column below the road, but would need to ensure that circulation is not restricted unless there was already grounded ice present. Smaller rivers require ice bridges, which are often constructed of aggregate chips and water and placed on grounded ice. Ice roads would be breached at stream crossings, especially if fish passage is a concern or the quantity of expected flow is significant during breakup. Required Operating Procedure C-3 ensures that accelerating stream velocity would not occur at break-up that would scour the channel or erode the bank.

Alternative A estimates a greater number of ice roads will be built than Alternatives B-1 and B-2, and fewer than Alternatives C and D. Under all of the alternatives, no long-term impacts are anticipated from ice roads or ice bridges.

Effects of Exploratory Drilling

Drilling operations require large amounts of water to create drilling fluid, which must be disposed of at the completion of drilling operations. Drilling fluid is typically a preparation of water, clay, and chemicals that is circulated into a well during drilling. A 10,000-foot well could require up 1.9 million gallons of water for drilling, in addition to approximately 100 gallons per day for each person in the drilling crew (for camp use). Alternative A projects up to 196 oil and gas exploration and delineation wells may be drilled. Required Operating Procedure A-2 requires all cuttings and drilling mud to be disposed of by injection, allowing on-pad temporary storage of muds and cuttings, as approved by Alaska Department of Environmental Conservation. Freshwater aquifers are protected by surface casing, which is installed and cemented in place at varying depths that are determined by State natural gas and oil regulatory agencies. Lease Stipulation D-1 prohibits exploratory drilling in rivers and streams, as determined by the active floodplain, and fish-bearing lakes, unless there is no feasible or prudent alternative. These protective measures will decrease the risk of drilling muds or oil from blowouts from entering adjacent waterbodies. Exploratory drilling under Alternative A is not expected to have a measurable effect on water quality since spills will occur in the winter and will likely occur on ice pads.

Effects of Drainage Disruption by Gravel Roads, Culverts, Pads, Runways, and Pipelines

Placement and construction of gravel pads, roadways, pipelines, bridges, runways, and culverts have the potential to divert, impede, or block flow in stream channels or shallow-water tracks, disrupting natural drainages. This disruption of streambeds and stream banks can remove protective shoreline vegetation and lead to channel erosion and sedimentation, formation of meltwater gullies, plunge pools from perched culverts, and formation of alluvial fans in streams and lakes (Lawson 1986). The passage of vehicle traffic over gravel pads and roads would result in dust and gravel being sprayed over waterbodies within 30 feet of the pad or road, and a noticeable dust shadow out to 150 feet or more, thereby increasing turbidity and sedimentation.

Stream crossing structures can create scour channels and channel bars in streams and cause erosion from the pads or roads and transport gravel into streams and lakes.

Blockages in areas with low flow capacity, especially culverts blocked by snow and ice, can result in seasonal and sometimes permanent impoundments (National Research Council 2003). The resulting inundation can affect tundra vegetation and possibly lead to thermokarst or creation of deeper, open waterbodies (Walker et al. 1987a, 1987b). Potential drainage pattern disruptions would be proportional to the acres of gravel and number of stream-crossing structures installed with each alternative.

Pipeline construction within the NPR-A would depend on the location and sequence of commercial-size discoveries. Narrow streams could be crossed using elevated pipelines on suspension spans. Wider, shallow rivers could be crossed by trenching and burying insulated pipelines in the riverbed. All entrenched crossings would be constructed in the winter at locations selected to minimize disturbances to tundra. All pipelines would be routed to avoid lakes.

Once installed, suspended and entrenched pipelines would have no effect on stream and water flow characteristics. Buried pipelines, which are less commonly used on the North Slope, could have potential thermokarst, subsidence, and possible exposure by stream erosion beyond the construction phase.

Impacts from drainage disruptions will be mitigated by Lease Stipulation E-2, which prohibits permanent oil and gas facilities within specified distances from waterbodies; Required Operating Procedure E-6 that requires that stream and marsh crossings be designed and constructed to ensure free passage of fish, reduce erosion, maintain natural drainage, and minimize adverse effects to natural stream flow; and Lease Stipulations K-1 (Rivers) and K-2 (Deep Water Lakes) which require setbacks from rivers and lakes for permanent oil and gas facilities to minimize the disruption of natural functions resulting from the loss or change to vegetative and physical characteristics of deep water lakes.

Because more or less infrastructure is estimated to occur in different alternatives, the potential for some shortcoming in design of infrastructure to result in impacts will vary with that variation among the alternatives. The stipulations and design requirements described above should provide adequate protection to ensure natural flow characteristics and water quality is maintained.

Effects of Gravel Pits

Removal of gravel from areas near streams and lakes can result in changes to stream or lake configurations, stream-flow hydraulics, lake shoreline flow patterns, alteration of hyporheic flow[3], erosion, sedimentation, and ice damming (National Research Council 2003). Locating gravel pits at an adequate distance from streams and lakes would minimize these impacts. Alternative sources of gravel for future development might include importing gravel from borrow sites east of the Colville River, extracting gravel from existing sites, processing bedrock, or using sand/silt/foam composites.

Gravel mining in the coastal plain would create some localized sedimentation and new or enlarged waterbodies, particularly if gravel was extracted from within floodplains. Gravel extraction outside the floodplain, especially within the foothills, would be less likely to create new lakes, but could produce sedimentation. Required Operating Procedure E-8 would locate gravel mine sites outside active floodplains whenever possible.

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[3] The percolating flow of water through sand, gravel, sediments and other permeable soils.

Alternatives A, C, and D would have roughly the same amount of new lakes from gravel mines since they have similar areas within the coastal plain available for leasing. Alternatives B-1 and B-2 would remove a large part of the coastal plain from leasing and development, so would likely result in fewer new lakes from gravel mining.

Effects from Waterflooding

Waterflooding is a process that can increase oil recovery from production wells. To maintain reservoir pressure, the volume of oil withdrawn from the reservoir must be replaced with an equivalent or greater volume of water. Water is injected into selected areas of the reservoir to maintain subsurface pressure and promote fluid flow up to the surface. This process requires such vast amounts of water that the high demand usually overwhelms local freshwater sources. Industry must instead rely on seawater and produced water. Waterflooding systems consist of seawater intake and treatment plants located on the coast, and an insulated pipeline that carries the seawater from the plant to production wells in the field.

Injection wells are a potential ground water contamination source if not properly sited, constructed, and maintained. The Alaska Oil and Gas Conservation Commission oversees the Underground Injection Control Program. This program protects underground sources of drinking water from contamination by oil and gas (Class II) injection activities. The Underground Injection Control Program requires the Commission to verify the mechanical integrity of injection wells, determine if appropriate injection zones and overlying confining strata are present, determine the presence or absence of freshwater aquifers, and ensure their protection. There have been no known cases of groundwater contamination and therefore no foreseeable impacts are expected from injection wells.

Effects of Oil Spills and Gas Releases

Oil spills could occur from pipelines, storage tanks, exploration and production facilities and infrastructure, drilling rigs, vehicles, and vessels. Spills leaving pads and roadbeds could enter water sources directly and reach tundra ponds, lakes, flowing creeks and rivers, and potentially the adjacent nearshore Beaufort or Chukchi Sea. Spills could occur anytime during the year. Processes that affect the fate of spills are spreading, evaporation, dispersion, dissolution, and emulsification (Boehm 1987; Payne et al. 1987; Lehr 2001).

Impacts of spilled oil would be the same in all alternatives, but since the number of small spills that might occur is related to the total production for the alternatives, the potential for these impacts varies proportionately to the oil projected to be produced.

Effects of Surface Oil Spills

Dispersion of oil spills in surface water occurs from wind, waves, currents, or ice. Given the cold temperatures in the Arctic, oil spills in fresh water should not spread rapidly, unless they are driven by strong winds. Shallow, marshy, ponded, or flooded tundra during the summer months can warm to about 64 °F (Miller et al. 1980), which would lower the viscosity of the oil and lead to spreading of the oil spill. Dissolved-oxygen concentrations in tundra waters could be affected by spilled oil in summer. The primary effect of a small spill on water quality in tundra ponds would be direct toxicity, though oxygen depletion could occur. Depending on the components of the oil spilled and the amount of dilution of the spill, even small spills could make water toxic for some aquatic life.

Oil spilled into streams would be driven and dispersed by stream currents. The oil would be driven downstream, likely accumulating in quiet pools and along natural and man-made structures that impede or redirect flow in the stream. The oil slick would move fastest along the centerline of the stream channel, where currents are the highest, leading to a dispersed oil slick elongated downstream. In near-bank areas, the oil slick would tend to accumulate, bind with sediments and vegetation, and become difficult to remediate (Overstreet and Galt 1995). This oil along the banks could be released at a later date and re-enter the main flow of the stream.

Spills into waterbodies with broken ice would spread between the ice floes into any gaps greater than 3 to 6 inches (Free et al. 1982). With knowledge of the time of year and the expected ice conditions, one can predict the likely configuration of oil spilled under, in, on, or among ice with a fair degree of confidence, which can be used to plan appropriate strategies for monitoring and responding to spills (Dickins et al. 2000).

Shear-dominated flows can create a special type of oil slick in rivers and along shorelines. Shear is caused by higher-speed flows on the surface interacting with slower moving water below it and along the edges of the river. This shear in currents along river banks, river bottoms, and shorelines causes turbulence that results in mixing and dispersion of the oil and can drive large quantities of the oil below the surface (Overstreet and Galt 1995). This can lead to oil accumulation in sediments and along river bottoms, and cause large quantities of oil to move below the surface and out of view of the clean-up crew.

Effects of Under-Ice Oil Spills

Oil spills under ice cover can bind to the ice. Studies by Glaeser and Vance (1971), NORCOR Engineering and Research (1975), and Comfort et al. (1983) have shown that the oil rises to the under-ice surface and spreads laterally, accumulating in under-ice cavities. Spills that occur when the ice sheet is growing become encapsulated in the ice. In the spring, as the ice melts, the oil rises to the surface in brine channels within the ice. The spread of an under-ice oil spill may be dispersed by currents in excess of 6 to 10 inches per second (Cammaert 1980; Cox et al. 1980). Current speeds in the nearshore Beaufort generally are less than 4 inches per second during the winter (Weingartner and Okkonen 2001). Such speeds were shown to be insufficient to strip oil from under an ice sheet after the oil had ceased to spread in a field study near Cape Parry in the Northwest Territories (NORCOR Engineering and Research 1975). If the ice is marine ice and moves during spring breakup, the oil contained with the ice moves with the ice. Thus, under-ice oil spills can be quite difficult to detect and especially difficult to remediate.

Effects of Gas Releases

Produced gas in the NPR-A is expected to be dry gas which may be accidently released from ruptured underground pipelines. Underground releases from a buried pipeline would bubble to the surface and continue into the atmosphere, where it would dissipate. Impacts to water resources and quality from gas releases are expected to be minimal. Gas from a ruptured buried pipeline could enter the bottom of a lake or stream, but would continue to rise through the surface water column and dissipate to the atmosphere without impacting water quality. Ice-cover conditions could prevent gas from venting to the atmosphere and result in a build-up of dangerous quantities of gas.

Effects of Abandonment and Reclamation

Removal of facilities, particularly roads, bridges, and culverts, would likely cause increased sedimentation and erosion immediately after removal. However, natural drainage will be reestablished within several years to more than a decade depending upon the facilities removed and the local hydrology and terrain. Leaving pads, airstrips, roads, bridges, and culverts in place, particularly without future maintenance, however, would result in longer-term, higher levels of erosion, sedimentation, and upslope impoundment. Ponds would be formed from melting of ice wedges or other ice underlying the gravel facilities. Leaving the roads in place, but removing bridges and culverts and breaching the roads where culverts had been placed, would reduce upslope impoundment. Alternative A could result in more sedimentation, erosion, and water impoundment during reclamation than Alternatives B-1 and B-2, but less than Alternatives C and D.

4.3.4.3 Effectiveness of Stipulations and Required Operating Procedures

These are a summary of required operating procedures and lease stipulations already discussed in the sections above which are protective of water resources and water quality.

Required operating procedures A-1 through A-7 would regulate garbage, wastewater, drilling wastes, fuel and chemical storage, fuel handling, and require spill prevention and clean-up plans. These required operating procedures would be effective in ensuring that waste materials associated with exploration and development activities were properly disposed of and help prevent impacts to water resources from spills and mishandling of materials. Required operating procedures B-1 and B-2 would prohibit water withdrawals from rivers during winter to protect over-wintering fish and regulate lake water withdrawals based on volume, depth, fish populations, and species diversification.

Required operating procedure C-2 requires ground operations to commence only when frost and snow are at sufficient depths to protect stream banks, minimize the breakage, abrasion, compaction, or displacement of vegetation and preventing future thermokarst. Required Operating Procedure C-3 requires crossings of waterway courses to be made using a low-angle approach, and that any reinforced crossings with additional snow or ice be removed before breakup. This requirement maintains natural spring runoff patterns, avoids flooding, minimizes streambed sedimentation, and ensures water quality is maintained. Required Operating Procedure C-4 prohibits travel up and down streambeds unless it can be demonstrated that there will be no impacts from such travel to over-wintering fish. Crossings of rivers and streams will be made at shallow riffles from point bar to point bar whenever possible.

Required Operating Procedure E-6 requires that stream and marsh crossings be designed and constructed to ensure free passage of fish, reduce erosion, maintain natural drainage, and minimize adverse effects to natural stream flow. Required Operating Procedure E-8 requires that gravel mine sites be located outside the active flood plain whenever possible, or serve as water reservoirs when located within flood plains.

Required Operating Procedure L-1 would protect stream banks and water quality by requiring low-ground-pressure vehicles to be used only on a case-by-case basis when studies have demonstrated that their use would only result in minimal impacts to soil and vegetation.

Lease Stipulation D-1 prohibits exploratory drilling in rivers and streams, as determined by the active floodplain, and fish-bearing lakes. This protects fish-bearing rivers, streams, and lakes from spills and minimizes alteration of riparian habitat with potential resultant sedimentation and erosion. Lease Stipulation E-2 prohibits permanent oil and gas facilities, with some limited exceptions, within specified distances from waterbodies. Construction camps are prohibited on frozen lakes and river ice in the Northeast NPR-A planning area. This stipulation protects fish-bearing waterbodies, water quality, and aquatic habitats. Lease Stipulation G-1 could require removal and reclamation of the developed site(s) upon field abandonment, which would eventually result in restoration of the natural drainage. Lease Stipulations K-1 (Rivers) and K-2 (Deep Water Lakes) require setbacks from rivers and lakes for permanent oil and gas facilities to minimize the disruption of natural functions resulting from the loss or change to vegetative and physical characteristics of deepwater lakes.

4.3.4.4 Conclusion

The potential impacts to water resources and quality from oil exploration and development activities under Alternative A include the following: turbidity changes of waterbodies due to thermokarst from seismic and overland travel activities and from dust effects adjacent to roads and pads; losses of water and possible water quality changes from water withdrawals; erosion and sedimentation associated with road and pad building; inadequately designed river crossing structures; impounded water at road crossings; alteration of drainages from pipelines, pads, ice and gravel roadways, airstrips, and gravel mines; and impacts on water quality from oil, produced water, and seawater spills into waterbodies.

Global climate change could have unpredictable impacts on winter temperatures, water balance and availability of water, timing and magnitude of spring floods, rising sea level, storm surges, and coastal erosion. A shortened winter season and warmer soil temperatures could increase the potential to damage vegetation from seismic surveys and overland travel and result in thermokarst. A longer growing season could result in increased potential evapotranspiration reducing available water in lakes. Premature melting of ice roads could occur with sudden spring melts, requiring emergency demobilization of drilling operations in order to protect the tundra. Increased snowfall combined with late summer rainfall could increase the magnitude of spring peak flows above the normal range of flows. Greater expanses of open water on the Beaufort and Chukchi seas could increase the potential for storm surges to cause accelerating rates of coastal erosion and flooding of inland lakes and ponds. All alternatives under consideration would be affected, although fewer impacts under Alternatives B-1 and B-2 would occur due to less development in the Teshekpuk Lake area.

Adherence to federal and State operational guidelines, best management and safety practices, planning requirements, lease stipulations and required operating procedures will all serve to reduce impacts from these activities. Some localized, but temporary effects to water resources or quality may occur from most activities described in Alternative A. The exception would be for permanent gravel pads and stream crossing structures and very large spills, which would have long-term impacts described in the above sections.

In general, impacts between alternatives are proportional to acres available to leasing and projected future production. Alternative A would be expected to have more impacts to water resources and quality than Alternatives B-1 and B-2, but less than Alternatives C and D.

4.3.5 Vegetation

This section discusses the potential effects to vegetation that could result from management action in the National Petroleum Reserve-Alaska (NPR-A) under Alternative A. It summarizes the information previously presented in the 1998 Northeast NPR-A IAP/EIS (U.S. Department of the Interior Bureau of Land Management and Minerals Management Service 1998), which has been amended with additional data from studies conducted since 1998, particularly for the Northwest NPR-A IAP/EIS (U.S. Department of the Interior Bureau of Land Management and Minerals Management Service 2003) and the Northeast NPR-A Supplemental IAP/EIS (U.S. Department of the Interior Bureau of Land Management 2008). It includes some more recent information for the entire NPR-A. It has also been updated with a new scenario for “reasonably foreseeable development” of oil and gas resources for the entire NPR-A.

4.3.5.1 Activities Not Associated with Oil and Gas Exploration and Development

Various types of activities not related to oil and gas leasing and development could affect vegetation in the NPR-A. Off-runway landings by private or commercial wheeled aircraft could cause short-term (less than 10 years) damage to vegetation present on the landing sites. Most wheeled aircraft landings would occur on sand or gravel bars or possibly on dry gravelly ridges. Therefore, impacts from such landings would likely be minor and sporadic in occurrence.

Archaeological and paleontological digs could impact vegetation, but would probably be limited to relatively small areas. Depending on the location of the dig, it could be possible to remove sod so that it could be replaced when activities at the site were concluded, resulting in a temporary disturbance. However, many digs would result in the destruction of vegetation at the site. Overall, the extent of these activities would likely impact only a few acres (4 to 6) in the NPR-A per year, spread out over several locations.

Camps associated with scientific studies (including those for potential future oil/gas development), recreational use, and other activities (including film permits) could result in trampling of vegetation from foot traffic and tent placement, and in small spills of stove or generator fuel. These impacts would typically be temporary, lasting from less than one to several growing seasons. Recreational camps are often located on river bars where vegetation cover is low. It is likely that larger camps would be located on existing gravel pads, which mostly lack vegetation. The total land surface impacted by all camps is expected to be small (less than 20 acres) and the sites would be scattered.

Overland moves occurring in the NPR-A typically involve traffic between Deadhorse and Barrow. Moves would occur during winter when the ground was frozen and covered with snow. Impacts to vegetation associated with transport vehicles depend on the type of vehicle, the vegetation type, and the snow conditions. In general, low-ground-pressure wheeled vehicles have less impact than do tracked vehicles or sleds on skids. In wetter tundra areas, impacts are usually limited to "green" trails caused by compression of snow and dead plant material, where standing dead vegetation has been laid down, leaving only newer, greener vegetation standing in the following summer. Such trails are often visible for one to several growing seasons. In general, wet areas may be less affected than dry areas (Walker 1996), and snow acts as a buffer against these impacts. Overall, vehicle tracks may affect vegetation, soil chemistry, soil invertebrates, soil thaw characteristics, and cause small-scale hydrologic changes (Kevan et al. 1995). Avoidance of areas with low snow cover, use of low-ground-pressure vehicles, dispersed traffic patterns, and minimizing sharp turns could help to minimize damage. However, tracked vehicles can disrupt the vegetation surface when making tight turns or by dropping the vehicle's blade too deeply into the snow. In wet tundra, this disruption can result in water accumulation and thermokarst. In drier tundra, travel over low shrubs can cause breakage and tussocks may be broken or crushed. If a trail across the NPR-A was about 12 feet wide; each 100 miles of its length would impact about 150 acres of tundra. Severity of impacts would depend upon the actual location and type of habitat, but impacts could range from temporary to longer-term.

Clean-up activities at former defense sites such as the Short Range Radar Site at Wainwright, or Point Barrow, often involving demolition of buildings or removal of contaminated gravel or soil, could occur at any time of the year and may total three to five cleanup operations throughout the NPR-A. Any such activities that extend beyond the gravel pads would more likely take place during winter and could have impacts to vegetation similar to those of overland moves, above, with the exception of excavations which, if necessary, would result in complete removal of vegetation. In the latter case, a site rehabilitation plan would be developed and implemented, with requirements, depending on the local substrate and size of the excavation.

The use of off-highway vehicles such as four-wheel vehicles and snowmachines could cause localized impacts to tundra. Snowmachines used during the winter when the ground is frozen with adequate snow cover would have little or no impact to the vegetation. However, heavy use of a trail could cause compaction of vegetation. In addition, heavy use of snowmachines during fall and late spring or in areas without adequate snow cover could result in damage to the vegetative mat, which may lead to thermokarst. Similarly, use of four-wheel vehicles and Argos (six- to eight-wheeled vehicles) on tundra disrupts the vegetation and soils in the upper portion of the profile, leading to thermokarst in wet tundra and damage or death of plants in drier areas. The use of airboats in shallow marsh areas could also impact aquatic vegetation and soils, although, if confined to the river channel, airboats (or other boats) would have no impact on aquatic vegetation.

4.3.5.2 Oil and Gas Exploration and Development Activities

Effects of Disturbances

Various activities associated with oil and gas exploration, development and production could impact vegetation in the NPR-A. These activities include seismic operations, exploration drilling, construction of ice roads and ice pads, construction of gravel roads, pads, and airstrips, and pipeline construction.

Exploration

The following analysis quantifies the potential impact of one 2-D survey and 10 3-D surveys over the next 30 years. It is reasonably foreseeable that Alternative A would result in one 3-D seismic survey in the first 10 years. It is foreseeable that four seismic surveys, one 2-D (approximately 500 linear miles), and three 3-D (one approximately 900 square miles each and the others at about 400 square miles each), could occur from 10–20 years. Producing fields would likely have repeated 3-D surveys to enhance recovery after 10 years of production (i.e., 10–30 years from plan implementation). These reshoots would amount to an additional four surveys at about 400 square miles each. Gas discoveries would likely be preceded by another two 3-D surveys at about 400 square miles each. Therefore, it is foreseeable, and assumed in this analysis, that there would be 11 seismic surveys acquired in the NPR-A under Alternative A over a 30-year period.

Seismic surveys to collect geological data and exploration drilling activities would occur during the winter months. Seismic exploration would cause impacts to vegetation similar to those described previously for overland moves. Two-D survey lines vary in length, but for this analysis, it is assumed a total of 500 miles of 2-D seismic data will be acquired in a single operation, with current technology, within a 900-square-mile area. The maximum area impacted by seismic lines would be approximately 12,121 acres (500 miles by 200 feet wide). This acreage is presented as a maximum because not all of the area within the 200-foot-wide path would be overrun by a vehicle. Trails would also be made by camp move vehicles, which would traverse about the same distance as line miles surveyed (Emers and Jorgenson 1997). Additional trails would be made while traveling to or from the survey area. For this analysis, it is assumed there will be six camp strings, each with five ski-mounted trailers, traversing a total of 523 miles. A camp move trail is about 12 feet wide. All trailer strings could use the same trail, but the resulting damage to vegetation would be more severe and longer lasting than if separate trails were used by each trailer string. This analysis assumes that six individual camp string trains would use different trails spread out over a 100-foot-wide area. With this scenario, camp moves would potentially impact 6,339 acres (523 miles by 100 feet wide). This survey work would be accomplished over a single winter, and would occur sometime in the first 10 years of plan implementation.

It is assumed that one 3-D seismic operation would cover a total of 900 square miles, and each of nine other 3-D seismic operations would cover a total area of 400 square miles (256,000 acres) involving a grid pattern of source and receiver lines, with source lines being less than 50 feet wide and receiver lines being about 100 feet wide. Source lines would be spaced about 1,500 feet apart and receiver lines about 1,100 feet apart. For each square mile surveyed, about 17 percent of the survey area would be impacted. The maximum area affected by survey lines for the 10 3-D surveys would be 496,125 acres. For 3-D surveys, the length of camp move trails would be less than those covered by 2-D surveys since a single move would occur down the center of the surveyed area. Camp move trails would impact about 23,467 acres of tundra for the 10 surveys. The combination of surveying and camp moves for the 10 3-D surveys would affect a maximum of 519,592 acres. When added to the acres disturbed by the single 2-D survey, a maximum of 538,052 acres would be affected in the NPR-A over 30 years (2.4 percent of the 22.8-million-acre NPR-A). This figure is presented as a maximum because not all of the area within a path would be overrun by a vehicle and because source and receiver lines would overlap in some areas.

A study of tundra disturbance associated with seismic surveys on the eastern portion of the North Slope reported little to no disturbance of tundra on 11 percent of the study plots 1 to 2 years following seismic surveys that occurred in 1984–85 (Jorgenson et al. 1996). Disturbance was considered low on 64 percent, moderate on 23 percent, and high on 2 percent of the plots used in this study. Eight to nine years following a survey, little to no disturbance was reported on 97 percent of the study plots, and no areas of moderate or high disturbance remained. Tundra under camp move trails showed little or no disturbance on 22 percent, low disturbance on 52 percent, moderate disturbance on 24 percent, and high disturbance on 2 percent of study plots. Eight to 9 years of recovery reduced the disturbance level to little or none on 85 percent, low disturbance on 10 percent, moderate disturbance on 4 percent, and high disturbance on 1 percent of plots. Using these approximations of disturbance and recovery, approximately 3,030 acres of vegetation would experience moderate to high impacts from survey lines immediately following the one anticipated 2-D seismic survey, and 124,031 acres of vegetation from the 10 anticipated 3-D surveys. In addition, moderate to high impacts for activity due to camp move trails could be found on approximately 1,648 acres for the 2-D and approximately 6,101 acres for 3-D surveys in the first summer following the surveys. Combining survey lines and camp moves for all 11 surveys, 133,428 acres would receive moderate to high disturbance, but spread out over 30 years. Eight to nine years following surveys, moderate to high impacts could be reduced to zero for seismic lines, 317 acres for the 2-D camp move, and 1,173 acres for the 10 3-D camp moves.

In a similarly designed but more recent study in the NPR-A, during the summer immediately following a 1999 seismic survey, the disturbance level to the affected tundra under seismic lines was little to none on 68 percent of study plots, low on 32 percent, moderate on 0 percent, and high on 0 percent (Yokel, unpublished data). After 6 years, recovery had reduced the disturbance level to little or none on 96 percent of study plots and low on 4 percent. After 12 years, those levels were scored on 98 percent and 2 percent of plots, respectively. On camp-move trails, the disturbance level to the affected tundra was little to none for 17 percent of study plots, low for 17 percent, moderate for 43 percent and high for 23 percent. After six years, recovery had reduced the disturbance level to little or none on 37 percent, with low on 43 percent, medium on 13 percent, and high disturbance on 7 percent of study plots. After 12 years, disturbance levels were little to none on 70 percent, low on 20 percent, moderate on 10 percent, and high on 0 percent of plots.

A study conducted in 2001, in the summer following seismic work, found little to no impacts to tundra under seismic lines on 30 percent of the plots studied (Jorgenson et al. 2003). Low impacts were found on 66 percent, and moderate impacts were found on 4 percent of the plots; no plots were highly impacted. Camp-move trails in this study had little or no impacts on 18 percent, low impacts on 54 percent, moderate impacts on 29 percent, and high impacts on none of the plots.

The 1999 and 2001 studies suggest that improvements in the equipment and procedures used for seismic surveys may have reduced the amount of impact to tundra, resulting in a higher percentage of tundra in categories of low or little to no impacts and few, if any, highly impacted sites. However, this conclusion is confounded with potential differences among studies in terrain types, snow cover, or observers' visual estimates of impacts. Calculations of area impacted by seismic operations in this document use environmentally conservative numbers; the projected, long-term (10 or more years) impacts are probably greater than actual impacts would be. Also, they would be spread out over 30 years, so not all that acreage would have the described levels of impact at one time.

During exploration, the construction of ice pads for drilling exploratory or delineation wells and ice roads and ice airstrips used to access the pads would impact vegetation in the NPR-A. In general, construction of ice roads, pads, and airstrips would have only localized impacts on vegetation, usually limited in wetter areas to compression of the tundra vegetation under the roads and pads and a shortened growing season for the plants in the following summer due to delayed melting of the ice in the spring. However, ice roads and pads could also cause breakage of shrubs and scuffing and crushing of tussocks in moist or drier habitats, and localized areas of plant death (Jorgenson 1999; Pullman et al. 2005; Yokel et al. 2007). Recovery from most impacts to vegetation would be expected within a few years. Under Alternative A, it is assumed there would be a total of 196 ice pads built for exploration and delineation wells. At 6 acres per pad, these would have short-term impacts on 1,176 acres of tundra, spread out over 30 years. It is also assumed that there would be 77.340 miles of some combination of ice roads, snow-packed trails and ice airstrips constructed throughout the NPR-A over a 30-year period. The total short-term disturbance from these would be 325,508 acres. Since vegetation recovery from these impacts is expected within a few years (Yokel et al. 2007), long-term disturbance from ice pads, ice roads, ice airstrips, and snow trails would be negligible. Although some evidence of crushed tussocks may still be apparent, new growth would preclude any exposed soils.

The construction of well cellars during exploration requires digging a hole that destroys vegetation on approximately 64 square feet (0.0015 acre) of ground, which replaces that vegetation with bare soils. Thermokarst associated with the disruption of the thermal regime in the surrounding soil may also change the vegetation type around the well collar to a wetter vegetation type. These impacts could result in 0.3 acre of vegetation being destroyed under Alternative A, assuming construction of 196 well cellars.

Development and Production

During oil and gas development and production, various activities could cause impacts to vegetation in the NPR-A. These activities include construction of gravel pads, roads, airstrips, and pipelines, excavation of material sites, and construction of ice roads. Impacts of ice roads were discussed previously under the "Exploration" subheading.

Placement of Gravel Fill

Construction of central processing facilities and gas compressor facilities, and associated satellite pads, roads, and airstrips, would result in the destruction of vegetation in areas where gravel was placed (Table 4-14 on page 76). The development scenario under Alternative A assumes that 12 central processing facilities (oil), 27 gas compressor facilities (gas) and associated satellite pads (16, oil; 60, gas), 38 gravel runways and in-field roads (701 miles) would be developed. In addition, it is assumed under Alternative A that two booster pump stations (oil) would be built on 5-acre gravel pads, and four staging bases would be built, covering 50 acres each. All gravel placement taken together would total 7,524 acres with all vegetation under it destroyed.

The passage of vehicle traffic over gravel pads and roads would result in dust and gravel being sprayed over vegetation within about 30 feet of the pad or road, and a noticeable dust shadow out to 150 feet or more. Within 30 feet of gravel structures, the dust and gravel could smother vegetation. The effects of dust on vegetation include early snowmelt, reduced soil nutrient concentrations, lower moisture, an altered soil organic horizon, and higher bulk density and depth of thaw (Everett 1980; Walker and Everett 1987; Auerbach et al. 1997). These studies found that plant species richness was reduced near gravel structures, particularly in naturally acidic soils. A decrease in acidophilus mosses, some lichen species, and certain heath taxa altered species composition (Walker and Everett 1987). In areas that experience heavy dust fallout, native plant communities could be killed and replaced by early-successional colonizers and species more tolerant of the altered site conditions (including possibly non-native, invasive species). The magnitude of these effects would depend on the duration of dust exposure (i.e., traffic intensity) and the distance from the source. Traffic volume and speed would generally be minor on in-field roads in the NPR-A, which would limit dust impacts to vegetation. Alternative A assumes a total of 701 miles of in-field gravel roads and 36 miles of airstrips with a potential for a total perimeter of 1,474 miles. Within 30 feet of gravel fill, up to 5,360 acres of vegetation could be subject to smothering by dust and gravel, and another 26,800 acres could be affected by a dust shadow.

The material used for gravel fill could also impact vegetation near gravel structures. Saline material used as fill increases the salinity of water draining off or leaching through the structure. Increased salinity at a site could alter the species composition of the plant community in the immediate vicinity of the gravel structure, shifting the community toward one comprised of species that are more tolerant of saline conditions (McKendrick 2000).

Construction of gravel pads, roads, and airstrips could alter the moisture regime of tundra near the structure by changing natural drainage patterns and areas where snow accumulates. Snowdrifts caused by gravel structures increase the wintertime soil-surface temperature and increase thaw depth in soils near the structures. These impacts are exacerbated by dust deposition (described above) and by the formation of impoundments (described below). These factors could combine to warm the soil, deepen thaw, and produce thermokarst adjacent to roads and other gravel structures (National Research Council 2003). Additionally, these changes could alter the species composition of the plant community near gravel structures. In general, most changes in the plant community around gravel structures would occur within 164 feet of the structure (Woodward-Clyde Consultants 1983). If all effects were to occur within this zone, a maximum of 29,301 acres would be impacted under Alternative A. Note that this area includes the 26,800 acres affected by dust discussed above, and is not in addition to it. It is presented as a maximum because not 100 percent of the area within 164 feet of roads and airstrips would be affected.

Blockage of natural drainage patterns can lead to the formation of impoundments. In the Prudhoe Bay oil field, impoundments covered 22 percent of a highly developed portion of the oil field and 3 percent of a broader portion of the oil field (Walker et al. 1987a). Impoundments, which would generally be confined to areas of wet and aquatic vegetation, could alter both the hydrology and species composition of wetlands. Plant productivity could increase biomass of a few species; or productivity may decrease, as a result of loss of plant communities to the development of deep, open water areas. In most cases, impoundments would lead to a decrease in plant species richness (Klinger et al. 1983; Walker et al. 1987a, b). The use of adequate cross-drainage structures in gravel roads and attention to the natural drainage patterns during design of developments could help reduce impacts to vegetation from impoundments.

Little is known about non-native, invasive, plant species in the NPR-A or the rest of the North Slope. One survey along the Dalton Highway detected two species of non-native invasive plants north of the Brooks Range crest (see section 3.3.1.3 in Volume 1). Highways such as the Dalton, rivers, and trails provide corridors for movement of non-native, invasive plants to uninfected areas. Many mechanisms may act as vectors for spread of non-native, invasive plants from these corridors, including equipment and vehicles used for exploration and construction. Although no non-native, invasive plants have been recorded in the existing North Slope oil fields, this may be because no formal surveys have been undertaken; there may in fact be some occurrences. The construction of gravel roads into and within the NPR-A would provide a mechanism for the spread of non-native, invasive plants into the NPR-A. The effects of dust and gravel spray from the roads may also provide a substrate suitable for colonization of non-native, invasive plants. In summary, oil and gas development in the NPR-A may cause, or accelerate, the invasion of the NPR-A by non-native, invasive plants. The potential for colonization by non-native, invasive plants could be reduced by pressure washing all equipment and vehicles before moving them into the NPR-A. This could effectively remove any seeds that wedge in cracks or crevices, or adhere to equipment or vehicles. Removing dirt from vehicles could also act to prevent potentially dangerous soil-borne pathogens or contaminants from being introduced to the NPR-A.

Material Sites

Gravel required for development in the NPR-A could be mined from existing sites east of the NPR-A, or could be extracted from new sites developed within the NPR-A. Investigations to identify gravel sources in the NPR-A have not been conducted for undiscovered oil and gas, although the Clover Mine Site west of Nuiqsut was identified for discovered oil during exploratory drilling and was subsequently further assessed. Additional surveys for gravel resources will presumably be initiated if further discoveries of recoverable oil and gas are made. Under Alternative A, it is assumed that up to 40 material sites, affecting a total of 1,415 acres, would be needed. Excavation of the gravel mine and stockpiling of overburden would destroy vegetation at gravel extraction sites.

Pipelines

Oil pipelines on the North Slope are typically built on vertical support members with a diameter of 12 inches and a spacing of 35 to 70 feet. In addition to the vegetation displaced by the vertical support member, installation of vertical support members disturbs a zone around the vertical support member that is approximately 20 inches wide. This zone of disturbance results from spoil material deposited around the vertical support members and from thermokarst, which may result in a change in species composition around the vertical support members. Approximately 0.05 acre of vegetation would be disturbed per pipeline mile for gathering lines, and 0.03 acre per mile of regional lines. Under Alternative A, 224 miles of gathering lines and 594 miles of regional oil pipelines would disturb 27 acres of vegetation through vertical support member placement. Ice roads built for construction of these pipelines would have only short-term impacts to vegetation, as described above for exploration activities, and would affect 3,469 acres. In reality, some of the vertical support members for gathering lines would be over gravel pads and would have no impacts on vegetation, nor would ice roads be necessary for constructing these portions of pipeline.

It is assumed that gas pipelines would be buried, so impacts to vegetation would be different than for oil pipelines. It is still assumed that a 35-foot-wide ice road would be built for pipeline construction. This short-term disturbance for gas gathering lines, regional gas pipelines, and a high-pressure gas pipeline would affect 3,233 acres. Pipeline burial, however, would destroy vegetation where the trench was constructed (4-foot-wide area) and would alter vegetation in adjacent areas where temporary storage of the overburden occurred (11-foot-wide area). The latter two disturbance types would be long-term in nature. Total long-term impacts from burial of gas gathering lines, regional gas pipelines, and a high-pressure gas pipeline would be 1,386 acres. Because of the difficulty colonizing species would have invading such a wide area, a recovery time of several years or longer may be expected, though wetter areas would generally revegetate before drier areas (McKendrick 2000).

Pipelines could also impact vegetation indirectly by altering snow accumulation patterns and by shading vegetation. Pullman and Lawhead (2002) found that most sites under the Alpine and Tarn pipelines did not differ substantially from nearby background areas located upwind. At about 25 percent of the sites sampled, substantially more snow accumulated under the pipeline, and at about 18 percent of the sites, substantially less snow accumulated under the pipeline. In general, the snowpack was most likely to be deeper under pipelines with an east-west orientation, and when pipeline clearance was reduced to below 5 feet.

Vegetation under a pipeline receives less direct sunlight during the growing season than does vegetation that is not under a pipeline. Therefore, there could potentially be a decrease of photosynthesis in plants growing under pipelines, and a reduction in heat absorption by the ground cover, leading to a shallower active layer. However, no data specifically address these questions. In general, Arctic plants are limited by nutrient availability rather than photosynthesis, and it is unlikely that pipeline shading substantially impacts vegetation physiologically (Tieszen 1978, Billings 1987, Bliss 2000).

Summer Tundra Travel

On a case-by-case basis, the BLM may permit low-ground-pressure vehicles to travel off of gravel pads and roads during periods other than when the ground is frozen and covered with snow. This is expected to be an uncommon occurrence, and if permitted at all, it would likely be only during early summer or late summer to fall. Because of restrictions that would be placed on this activity, impacts to vegetation should be limited to the compression of standing vegetation, similar to what happens during winter following traffic by low-ground-pressure vehicles.

Air Pollution

Various activities associated with oil development and production emit air pollutants, including oxides of nitrogen and sulfur (NOx, NO_2, NO, and SO_2). Sunlight reacts with nitrogen oxides in the troposphere (lowest portion of the atmosphere) to create ozone

(O_3). Numerous studies have addressed the impacts of these pollutants on both vascular and non-vascular plants, but there are few studies of air pollutant impacts on tundra vegetation. Kohut et al. (1994) measured air pollutant concentrations and their effects on vegetation adjacent to the Central Compressor Plant, where gas-powered turbine pumps compress natural gas prior to injection, in the Prudhoe Bay oil field. The Central Compressor Plant is the largest source of nitrogen oxides in the Prudhoe Bay oil field, producing NOx, NO_2, and NO, as well as SO_2, and O_3 indirectly through the reaction described above. Emissions from the Central Compressor Plant did not have effects on the local vegetation (Kohut et al. 1994). Results did show an increase in foliar nitrogen near the Central Compressor Plant, but no visible injury to plants was found. Physiological changes (photosynthesis and respiration) in plants were not apparent in either field or growth chamber experiments for any of the pollutant gases, even at concentrations greater than those measured near the Central Compressor Plant. Primary productivity in Arctic tundra, however, is often limited by nutrient supply, particularly nitrogen and phosphorus (Chapin 1978; McKendrick and Mitchell 1978; Chapin et al. 1980; Chapin and Shaver 1985). Fertilization leads to higher productivity and changes in the structure of Arctic plant communities (Chapin and Shaver 1985, McKendrick 1997), and may alter carbon balance at the ecosystem level (Billings et al. 1984).

Abandonment and Reclamation

During abandonment activities, vegetation and wetlands would be impacted by dust fallout along roads, by ice roads and other off-road tundra travel associated with dismantling of pipelines and power lines, and by disturbance to vegetation adjacent to vertical support members and power line poles during their removal. The level of impact from these activities would be roughly the same as that during construction if gravel fill was removed; impacts would be less if the gravel were left in place. If roads and pads were left in place, and especially if cross drainage across roads was not maintained, water impoundment would occur, and could alter plant communities as described for the construction period. It is also likely that the non-maintained roads would have occasional washouts, where tundra vegetation would be covered with washed-out gravel. Roads and pads, if left in place, would likely need to be revegetated with plants native to gravel bars and ridges in the Arctic (i.e., different from the plant communities surrounding the facilities). Revegetation activities could take several years, as initial attempts are not always successful. Removal of gravel from pads, roads, and airstrips could be mandated. Partial or complete removal of gravel can result in faster reestablishment of native plant growth, although establishment can take many years (more than a decade). The use of mulch and soil mycorrhizae might partially remedy this issue, if the mycorrhizae can be identified and isolated from the surrounding soil. In addition, thaw subsidence is difficult to predict, and complete restoration to preexisting conditions is not likely.

Effects of Spills and Gas Releases

Spills of refined oil could occur during overland moves and seismic surveys. These spills would likely be small, averaging 3 to 5 gallons or less, and would affect small areas (less than 50 square feet). Contaminated snow would be cleaned up immediately upon discovery. A spill from a large storage tank, which would be less likely, could impact up to 500 square feet (USDOI BLM 2008). Overall, past spills of this size and type on Alaska's North Slope have caused minor ecological damage and ecosystems have generally recovered, with wetter areas recovering more quickly than drier areas (Jorgenson 1997, McKendrick 2000). There are techniques that may accelerate the cleanup process after an oil spill (e.g., Yakubu et al. 2009).

Spills from production activities could involve crude oil, refined products, produced water, or seawater. Typical refined products that are spilled on the Alaska North Slope include aviation fuel, diesel fuel, engine lube oil, fuel oil, gasoline, grease, hydraulic oil, transformer oil, and transmission oil. The extent of environmental impacts of a spill or gas release would depend upon the type and amount of materials spilled or released, the location of the spill or release, and effectiveness of the response. The majority of small spills would be contained on the gravel pad and would have no impact on vegetation. Approximately 20–35 percent of past crude oil spills have reached areas beyond pads (USDOI BLM 2008). For this analysis, it was assumed that 27 percent of all spills would occur or reach beyond gravel pads. Most spills would happen during the winter and could be cleaned with minimal impacts to vegetation. If it is assumed that 60 percent of all spills would occur during the winter, approximately 11 percent of all oil spills would reach vegetation during the snow-free season and have more than a minimal effect. Under Alternative A, this would mean 58 of the 526 crude and refined oil spills assumed to occur over the life of the plan.

Most oil spills would cover less than 500 square feet (less than 0.01 acre). However, a spill event that includes an aerial pressured discharge can cover substantially more area as occurred at an ARCO drill site in 1993 when just 1 to 4 barrels of crude oil misted over an estimated 100–145 acres (Ott 1997). (Such a spill is a very low-probability event, occurring less than once out of the total spills expected throughout the life of this plan. Thus, its magnitude is not apparent in the following acreages). Assuming the average spill would cover 0.1 acre, under Alternative A, approximately 6 acres would be impacted substantially during the lifetime of development in the NPR-A.

Oil spills on wet tundra kill the moss layers and aboveground parts of vascular plants, and sometimes kill all macroflora at the site (McKendrick and Mitchell 1978). Damage to oil-sensitive mosses could persist for several years if the site were not rehabilitated. The length of time a spill would persist would be dependent upon soil moisture and the concentration of the product spilled. McKendrick (2000) reported that complete vegetation recovery occurred within 20 years on a wet sedge meadow without any cleanup. A dry habitat exposed to the same application supported less than 5 percent vegetative cover after 24 years. Overall, past spills on Alaska's North Slope have resulted in minor ecological damage and ecosystems have shown good potential for recovery because most of the habitat is wet (Jorgenson 1997).

If seawater were used for enhancement of oil production, a saltwater spill could occur within the NPR-A. According to McKendrick (2000), brine spills kill plants on contact and increase soil salinity to the point that many species cannot survive. Unlike oil, salts are not biodegradable, and natural recovery occurs only after salts have leached from the soil. A saltwater spill would have effects on salt-intolerant vegetation near the seawater pipeline, but the amount of tundra habitat affected would be limited to a few acres or less. In the case of a saltwater spill on tundra, the water would likely be absorbed into the vegetative mat or, in wet habitats, diluted with fresh water.

Oil spill or gas release response training and cleanup may also impact vegetation. Trampling of vegetation and stockpiling of materials for use during the response may impact vegetation. The amount of impact would depend on the size and location of the spill, but in most cases would be temporary, and plants would recover in one to several years.

A single gas release occurring with ignition could have thermal effects to approximately 194 acres of tundra vegetation (500-meter radius). The assumed number of gas releases under Alternative A (2.4 = 0.9 incidents per 300 pipe miles times 799 miles of pipe), if ignited, would result in thermal effects to approximately 466 acres of tundra. If a wildfire resulted, additional acreage would burn, the amount depending on season, weather conditions, moisture content of vegetation, and suppression effort. Most North Slope tundra fires are less than 1,000 acres (Racine and Jandt 2008). Total vascular plant cover following lightning-caused tundra fires reached 50–100 percent after 5 to 6 years (Racine et al. 1987). Lichens, however, could take several decades to recover, if they can achieve former densities at all under a climate-warming regime (Jandt et al. 2008).

4.3.5.3 Effectiveness of Stipulations and Required Operating Procedures

Lease stipulations and required operating procedures described in Table 2–3 (Volume 1), if properly implemented, should effectively reduce the impacts of development on vegetation under Alternative A. Specific Required Operating Procedures A-1 through A-7 on solid and liquid-waste disposal, fuel handling, and spill cleanup would be expected to reduce the potential effects of intentional releases, spills, and solid waste on vegetation. Required Operating Procedures A-9 and A-10 would reduce air pollution. Required Operating Procedure C-2 on overland moves and seismic work would also effectively minimize impacts to vegetation.

Lease stipulations on activities associated with oil and gas exploration (D-1 and D-2) and required operating procedures affecting development (E-4, E-5, E-6, and E-12), such as facility design and construction of pipelines, roads, drill pads, airstrips, and other facilities, are expected to effectively minimize the amount of habitat that would be altered by gravel pads and other surface disturbances. Lease stipulation G-1 would facilitate the regrowth of native vegetation following facility abandonment. The setbacks outlined in lease stipulations (K-1, K-2, K-3, K-4, K-7, K-8, and K-11) associated with development near rivers, lakes, and other specified habitats would be effective at minimizing impacts in high-value wetlands, such as areas dominated by pendant grass and riparian and floodplain habitats. Required Operating Procedure L-1 would minimize the impacts to vegetation of summer tundra travel, if such an action is permitted.

4.3.5.4 Conclusion

Under Alternative A, impacts to vegetation from activities other than oil or gas development would include minor impacts to vegetation from aircraft landings, archaeological or paleontological excavations, camps, and overland moves, and would affect less than 200 acres of vegetation per year. The duration of the actions causing these impacts would be short-term, ranging up to five months, and recovery would vary from one to several years. Some impacts from snow machines and ATVs, where the same trail is followed continuously such as near villages, could be major (but localized) and would not recover as long as the traffic continues.

Impacts to vegetation from oil and gas exploration would occur from seismic work and construction of well cellars during exploratory drilling and the construction of ice roads and ice pads. The duration and recovery time for impacts associated with seismic work would be similar to those for overland moves. Based on earlier studies, there should be no substantial, long-term impacts to vegetation from seismic lines, but camp-move trails could substantially impact approximately 1,490 acres after 8 to 9 years. Effects of well cellar construction would also be long-term, but would impact less than 3 acres of vegetation.

The effects of oil and gas development and operation would include destruction of vegetation during construction of gravel pads (central processing facilities or gas compressor facilities, satellite drill pads, pump stations, and staging bases), roads, and airstrips, from excavation of material sites and burial of gas pipelines, construction of vertical support members, and the potential for colonization of these areas by non-native, invasive species. These impacts would be long-term and would impact about 9,902 acres, or 0.04 percent of the 22.8-million-acre NPR-A. Plant communities could also be altered by dust deposition, salinity of gravel fill used in construction, snowdrifts, and blockage of or change to natural drainage patterns. These impacts would be also be long-term and would impact about 29,301 acres, or 0.13 percent of the NPR-A.

Spills of oil, other chemicals, and saltwater could occur and would have long-term impacts, except for those associated with small-size spills, which would be cleaned up immediately, allowing recovery within a few years to two decades.

It is assumed that impacts to vegetation types or communities would occur in proportion to their occurrence within the NPR-A. However, precluding development in a large block in the south and west of NPR-A would disproportionately conserve dwarf shrub, tussock tundra, and sparsely vegetated communities.

Impacts to vegetation from non-oil and gas activities, and from oil and gas activities, would likely be additive, as opposed to compensatory, except in those areas where the two types of activities overlapped. Impacts to vegetation from exploration and development activities would also be additive, except where development activities occurred in areas previously disturbed during exploration. In areas where two or more activities occurred, overall impacts would reflect those impacts associated with the first activity and any new impacts associated with later activities. Because of the different exploration and development scenarios for each alternative, short-term impacts to vegetation resources in terms of areal extent under Alternative A would be about 39 percent more than Alternative B-1, 29 percent more than Alternative B-2, 26 percent less than Alternative C, and 30 percent less than Alternative D. Long-term impacts to vegetation resources in terms of areal extent under Alternative A would be about 39 percent more than Alternative B-1, 23 percent more than Alternative B-2, 27 percent less than Alternative C, and 35 percent less than Alternative D.

Recovery of tundra vegetation to its original composition from any of the above impacts may be delayed or precluded entirely as a result of simultaneous effects of climate change, which may lead to even greater shifts in plant species composition. These shifts may be toward increased shrub height and cover extent (Chapin et al. 1995; Sturm et al. 2001; Walker et al. 2006; SNAP 2010), increased grass and sedge (including cottongrass) species in some areas and declines of graminoids in other areas (Anderson and Weller 1996). These increases would likely be at the expense of lichen and moss cover (Chapin et al. 1995; Cornelissen et al. 2001, Jorgenson and Buchholtz 2003, Epstein et al. 2004, Walker et al. 2006, Scenarios Network for Alaska Planning 2011). In addition, warmer soil temperatures are likely to increase thermokarst, and increases in sea level may inundate low-lying tundra areas, increasing salt marsh, aquatic, and wet tundra vegetation types and erosion of coastal bluffs (Arctic Climate Impact Association 2004). Such impacts of climate change could accumulate with any changes in soil thermal regimes that might occur as a result of past and future non-oil and gas and oil and gas activities in and near the NPR-A, potentially leading to synergistic impacts to vegetation.

4.3.5.5 Potential New Mitigation Measure—Weed-Free Vehicles (new required operating procedure)

Objective: Prevent the introduction, or spread, of non-native, invasive plant species in the NPR-A.

Requirement/Standard: Ensure that all equipment and vehicles (intended for use either off or on roads) are weed-free prior to transporting them into the NPR-A. Monitor annually along roads for non-native invasive species, and initiate effective weed control measures upon evidence of their introduction. Prior to operations in the NPR-A, submit a plan for the BLM's approval, detailing the methods for cleaning equipment and vehicles, monitoring for weeds and weed control.

Potential Benefits and Residual or Unavoidable Impacts: This potential new mitigation measure would reduce the probability that non-native, invasive plant species would become established and spread in the NPR-A. Such establishment and spread would be at the expense of other, naturally occurring plant species that would be displaced, as well as to the wildlife species that use those plants. Non-native, invasive plant species have become a serious problem in other parts of the Nation and are now becoming a problem in Alaska. Although there is a cost to vehicle operators associated with cleaning equipment and vehicles, and to lessees associated with monitoring roads, that cost would be minor compared to the costs of eradicating a well-established, non-native, invasive plant species, and the costs to society of altered ecosystems. Despite this mitigation, residual, unavoidable impacts could occur if a seed source were incompletely cleaned from a vehicle and the seed happened to fall off away from roads and in an area suitable for colonization.

4.3.6 Wetlands and Floodplains

This section discusses the potential effects to wetlands and floodplains that could result from management action in the NPR-A under Alternative A. It summarizes the information previously presented in the 1998 Northeast IAP/EIS (U.S. Department of Interior Bureau of Land Management and Minerals Management Service 1998), which has been amended with additional data from studies conducted since 1998, particularly for the Northwest IAP/EIS (U.S. Department of Interior Bureau of Land Management and Minerals Management Service 2003) and the Northeast Supplemental IAP/EIS (U.S. Department of Interior Bureau of Land Management 2008). Its analysis has been expanded to encompass the unplanned southern portion of the NPR-A, and updated with a revised scenario for "reasonably foreseeable development" of oil and gas resources.

In compliance with Executive Order 11990, (Protection of Wetlands) and Executive Order 11988, (Floodplain Management), the BLM has prepared impact analyses on those areas within the NPR-A that are considered to be wetlands or floodplains, as described in section 3.3.2 "Wetlands and Floodplains" in Volume 1.

Approximately 95 percent of the vegetated land in the NPR-A is considered wetlands, according to established criteria for determining wetland status (see section 3.3.2.2 in Volume 1). It is likely, and therefore assumed, that nearly all ground-disturbing actions to vegetation will also be impacting wetlands for the purposes of calculating short- and long-term impacts. Section 4.3.5 describes impacts to vegetation with detailed calculations of disturbed acres for long and short-term impacts. Summaries of these calculations will be presented in the following sections.

4.3.6.1 Activities Not Associated with Oil and Gas Exploration and Development

Various types of activities not related to oil and gas leasing and development could affect wetlands and floodplains in the NPR-A. Off-runway landings by wheeled aircraft could cause short-term damage to vegetation present on the landing sites. Most wheeled aircraft landings would occur on sand or gravel bars or ridge tops. Aircraft and watercraft both have the potential for small (less than 5 gallons) fuel spills during refueling. Impacts from such landings and refueling spills would likely be dispersed and minor in occurrence.

Archaeological and paleontological digs could impact wetlands, but would be limited to relatively small areas. Depending on the location of the dig, sod could be removed for the duration of the excavation and replaced once activities concluded, resulting in a temporary disturbance. However, many digs would result in the destruction of vegetation at the site. Overall, the extent of these activities would likely impact only a few acres in the NPR-A per year, spread out over several locations.

Camps associated with scientific studies (including those for potential future oil/gas development), recreational use, and other activities (including film permits) could result in compaction of vegetation from foot traffic and tent placement, and in small spills of stove or generator fuel. These impacts would typically be temporary, lasting from less than one to several growing seasons. Recreational camps are often located on river bars in the floodplain where vegetation cover is sparse. It is likely that larger camps would be located on existing gravel pads, which mostly lack vegetation or at existing landing strips such as Inigok. The total land surface impacted by all camps is expected to be small and the sites would be scattered.

Overland moves occurring in the NPR-A have historically involved traffic between Deadhorse and Barrow. Moves would occur during winter when the ground was frozen and covered with snow. Impacts to wetlands associated with transport vehicles depend on the type of vehicle, the vegetation type, and the snow conditions. In general, low-ground-pressure wheeled vehicles have less impact than do tracked vehicles or sleds on skids. Vehicle tracks may affect wetlands, soil chemistry, soil invertebrates, soil thaw characteristics, and cause small-scale hydrologic changes (Kevan et al. 1995). Tracked vehicles can disrupt the vegetation surface when making tight turns or by dropping the vehicle's blade too deeply into the snow. In wet tundra, this disruption can result in water accumulation and thermokarst. In drier tundra, travel over low shrubs can cause breakage and tussocks may be broken or crushed. Severity of impacts would depend upon the actual location and type of habitat, but impacts could range from temporary to longer-term. Avoidance of areas with low snow cover, use of low-ground pressure vehicles, dispersed traffic patterns, and minimizing sharp turns could help to minimize damage

Cleanup activities at former defense sites such as the Short Range Radar Site at Wainwright, or Point Barrow, could occur at any time of the year and may total three to five cleanup operations throughout the NPR-A. Activities that extend beyond the gravel pads would more likely take place during winter and could have impacts to wetlands similar to those of overland moves, with the exception of excavations, which would result in complete removal of vegetation.

The use of off-highway vehicles such as four-wheel vehicles and snowmachines could cause localized impacts to wetlands and floodplains. Off-highway vehicles used during the winter when the ground is frozen with adequate snow cover would have little or no impact, unless trails are heavily used, causing compaction of vegetation. In addition, heavy use of snowmachines in areas without adequate snow cover could result in damage to the vegetative mat, which may lead to thermokarst in wet areas and damage to plants in drier areas.

4.3.6.2 Oil and Gas Exploration and Development Activities

Various activities associated with oil and gas exploration, development and production could impact wetlands and floodplains in the NPR-A. These activities include overland moves, seismic operations, exploration drilling, construction of ice roads and ice pads, summer tundra travel, gravel roads, gravel pads for pump stations, central processing facilities, gas compressor facilities, and staging bases, airstrips, pipeline construction, and gravel mine sites. Table 4-14 lists estimated surface areas disturbed under each alternative.

Exploration

Seismic surveys to collect geological data would occur during the winter months. Impacts to wetlands and floodplains would be similar to those described for overland moves (see section 4.3.6.2). Seismic equipment and vehicles used today employ low-ground-pressure equipment and designs and have much less impact to the tundra than older equipment, but camp moves can still impact the tundra and cause long-term impacts such as thermokarst (WesternGeco 2003). Results of studies of impacts to vegetation from seismic activity and calculations of disturbed ground are discussed in detail in section 4.3.5.2. Alternative A estimates 538,052 acres of short-term impacts and 1,490 acres of long-term impacts over the 30-year period from seismic surveys.

During exploration, the construction of ice roads, ice pads, ice airstrips and snow trails used to access drill pads could impact wetlands and floodplains in the NPR-A. These activities would have only localized impacts on vegetation, usually limited in wetter areas to compression of the tundra vegetation under the roads and pads, and a shortened growing season for the plants in the following summer due to delayed melting of the ice in the spring. Recovery from most impacts to vegetation would be expected within a few years. Ice airstrips are commonly built on the grounded ice of large lakes, but if they were built over tundra, they would result in impacts similar to ice roads.

Under Alternative A, it is assumed there would be a total of 325,508 acres of short-term disturbance from ice roads, snow-packed trails, ice airstrips, and ice pads for wells. Since vegetation recovery from these impacts is expected within a few years (Yokel et al. 2007), long-term disturbances would be negligible.

The construction of well cellars during exploration requires the digging of a hole that destroys vegetation on approximately 64 square feet of ground, replacing that vegetation with bare soils. Thermokarst associated with the disruption of the thermal regime in the surrounding soil may result or the vegetation type around the well cellar will change to a wetter vegetation type. Impacts from all alternatives will amount to less than 0.4 acre and will be proportional to the number of wells drilled.

Development and Production

During oil development and production, various activities could cause impacts to wetlands and floodplains in the NPR-A. These activities include construction of gravel pads for pump stations, staging bases and central processing facilities, roads, pads, airstrips, pipelines, excavation of material sites, summer tundra travel, and construction of ice roads.

Construction of central processing facilities and gas compressor facilities, and associated satellite pads, roads, and airstrips, would result in the long-term destruction of 7,524 acres of wetlands in areas where gravel was placed.

Blockage of natural drainage patterns can lead to the formation of impoundments, which could alter both the hydrology and species composition of wetlands. Plant productivity could increase, favoring a few species, or decrease due to the development of deeper, open water areas. The use of adequate cross-drainage structures in gravel roads and attention to the natural drainage patterns during design of developments could help reduce impacts to wetlands from impoundments.

Changes to plant communities from dust and gravel sprayed over vegetation and changes in moisture regime and impoundments adjacent to roads and pads is discussed in section 4.3.5.2. Impacts to plant communities around gravel structures would occur within 164 feet of the structure (Woodward-Clyde Consultants 1983). If all effects were to occur within this zone, a maximum of 29,301 acres would be impacted under Alternative A.

Saline material used as fill increases the salinity of water draining off or leaching through the structure. Increased salinity at a site could alter the species composition of the plant community in the immediate vicinity of the gravel structure, shifting the community toward one comprised of species that are more tolerant of saline conditions (McKendrick 2000).

Removal of gravel from areas near streams and lakes can result in changes to stream or lake configurations, stream-flow hydraulics, lake shoreline flow patterns, erosion, sedimentation, and ice damming (National Research Council 2003). Excavation of gravel and stockpiling of overburden would destroy wetlands at gravel-extraction sites and create ponds. Locating gravel pits an adequate distance from streams and lakes would minimize these impacts. It is possible to design gravel pits to enhance fish habitat at the end of the mining operations if they are located in the floodplain. Alternative sources of gravel for future development might include importing gravel from borrow sites east of the Colville

River, extracting gravel from existing sites, processing bedrock, or using sand/silt/foam composites. Alternative A estimates up to 40 gravel pits (1,415 acres) could be required for the development scenario.

Section 4.3.5.2 presents a detailed discussion of impacts from pipelines to vegetation. Oil pipelines on the North Slope will incur a zone of disturbance around the vertical support members, which may result in vegetation changes. Alternative A could disturb up to 27 acres of vegetation through vertical support member placement. Ice roads built for constructing these pipelines would have only short-term impacts to vegetation, as described above for exploration activities, and would affect 3,469 acres. It is assumed that gas pipelines would be buried, so impacts to vegetation would be different than for oil pipelines. This short-term disturbance for gas-gathering lines, regional, and high-pressure gas pipelines would affect 4,843 acres. Pipeline burial, however, would destroy vegetation where the trench was constructed and would alter vegetation in adjacent areas where temporary storage of the overburden occurred. The latter two disturbance types would be long-term in nature. Total long-term impacts from burial of gas pipelines would be 1,386 acres.

Low-ground-pressure vehicles may be permitted to travel off of gravel pads and roads during periods other than when the ground is frozen and covered with snow. This activity is commonly associated with pipeline inspections and spill-prevention and preparedness measures required in spill-prevention plans during the summer. Booms may be transported and placed across streams downstream from pipelines. These booms are left in place through the summer to capture any oil that might spill from a pipeline and then would be retrieved, again probably using low-ground-pressure vehicles, before freeze-up. Because of restrictions that would be placed on this activity, impacts to vegetation should be limited to the compression of standing vegetation, similar to what happens during winter following traffic by low-ground-pressure vehicles.

Abandonment and Reclamation

During abandonment activities, wetlands would be impacted by dust fallout along roads, by ice roads and other off-road tundra travel associated with dismantling of pipelines and power lines, and by disturbance to vegetation adjacent to vertical support members and power line poles during their removal. The level of impact from these activities would be comparable to those during placement of the gravel fill, vertical support members, and power poles. If roads and pads were left in place, and especially if cross drainage across roads was not maintained, water impoundment would occur, and could alter plant communities. It is also likely that the non-maintained roads would have occasional washouts, where tundra vegetation would be covered with washed-out gravel. Roads and pads, if left in place, would likely need to be re-vegetated. Partial or complete removal of gravel can result in faster reestablishment of native plant growth, although establishment can take many years. In addition, thaw subsidence is difficult to predict, and complete restoration to preexisting conditions is not likely. Approximately 8,784 acres of gravel fill could be reclaimed under Alternative A.

Effects of Spills and Gas Releases

Spills of oil or fuel could occur during winter exploration activities such as overland moves and seismic surveys. These spills would likely be small, averaging 3 to 5 gallons or less, and would affect small areas (less than 50 square feet). Contaminated snow would be cleaned up immediately upon discovery. A spill from a large storage tank, which would be less likely, could impact up to 500 square feet (USDOI BLM 2008). Overall, past spills of this size and type on Alaska's North Slope have caused minor ecological damage and ecosystems have generally recovered, with wetter areas recovering more quickly than drier areas (Jorgenson 1997, McKendrick 2000).

Spills from production activities could involve crude oil, refined products, fuel, produced water, or seawater. The extent of environmental impacts of a spill or gas release would depend upon the type and amount of materials spilled or released, the location of the spill or release, whether the ground is frozen, and effectiveness of the response. The majority of small spills would be contained on the gravel pad and would have no impact on wetlands and floodplains.

Oil spills on wet tundra kill the moss layers and aboveground parts of vascular plants, and sometimes kill all macroflora at the site (McKendrick and Mitchell 1978). Damage to oil-sensitive mosses could persist for several years if the site were not rehabilitated. The length of time a spill would persist is dependent upon soil moisture and the concentration of the product spilled. Overall, past spills on Alaska's North Slope have resulted in minor ecological damage and ecosystems have shown good potential for recovery because most of the habitat is wet (Jorgenson 1997).

An estimated 11 percent of all spills would occur in the summer and leave gravel pads. This would result in 58 small spills over the life of the plan in Alternative A. Assuming an average spill would cover 0.1 acre, an estimated 6 acres could be impacted over the period of development in Alternative A.

A single gas release occurring with ignition could have thermal effects on approximately 194 acres of tundra vegetation. If a wildfire resulted, additional acreage would burn, the amount depending on season, weather conditions, moisture content of vegetation, and suppression effort. The assumed number of gas releases under Alternative A would result in thermal effects to approximately 466 acres of tundra.

If seawater were used for enhancing oil production, a saltwater spill could occur within the NPR-A. According to McKendrick (2000), brine spills kill plants on contact and increase soil salinity to the point that many species cannot survive. Unlike oil, salts are not biodegradable, and natural recovery occurs only after salts have leached from the soil. A saltwater spill would have effects on salt-intolerant vegetation near the seawater pipeline, but the amount of tundra habitat affected would be limited to a few acres or less. In the case of a saltwater spill on tundra, the water would likely be absorbed into the vegetative mat or, in wet habitats, diluted with fresh water.

4.3.6.3 Effectiveness of Stipulations and Required Operating Procedures

Lease stipulations and required operating procedures described in Table 2–3 (Volume 1), if properly implemented, should effectively reduce the impacts of development on wetlands and floodplain under Alternative A. Required Operating Procedures A-1 through A-7, which address solid and liquid-waste disposal, fuel handling, and spill cleanup would be expected to reduce the potential effects of intentional releases, spills, and solid waste on wetlands and floodplains. Required Operating Procedure C-2, which addresses overland moves and seismic work, would also effectively minimize impacts to wetlands and floodplains by requiring sufficient depths of frost and snow to protect vegetation. Offsets may be required to avoid using the same route or track in the subsequent year. These requirements will protect stream banks; minimize compaction of soils; and minimize the breakage, abrasion, compaction, or displacement of vegetation.

Lease stipulations on activities associated with oil and gas exploration (D-1 and D-2), prohibiting drilling in streams and construction of permanent structures during exploratory drilling, and required operating procedures affecting development (E-4, E-5, E-6, and E-12), such as facility design and construction of pipelines, roads, drill pads, airstrips, and other facilities, are expected to effectively minimize the amount of habitat that would be altered by gravel pads and other surface disturbances. Required Operating Procedure E-8 directs placement of gravel mine sites outside the active floodplain, whenever possible, or requires them to serve as water reservoirs when located within floodplains. Lease Stipulation G-1 would facilitate the regrowth of native vegetation following facility abandonment. The setbacks outlined in lease stipulations (K-1, K-2, K-3, K-4, K-7, K-8, and K-11) associated with development near rivers, lakes, and other specified habitats would be effective at minimizing impacts in high-value wetlands, such as areas dominated by riparian and floodplain habitats. Required Operating Procedure L-1 would minimize the impacts to wetlands and floodplain of summer tundra travel, if such an action is permitted.

4.3.6.4 Conclusion

Approximately 95 percent of the vegetated land in the NPR-A is considered wetlands, according to established criteria for determining wetland status. It is likely, and therefore assumed, that all ground-disturbing actions to vegetation will also be impacting wetlands for the purposes of calculating short and long-term impacts.

Under Alternative A, impacts to wetlands and floodplains from activities other than oil or gas development would include minor impacts from aircraft landings and refueling, archaeological or paleontological excavations, camps, and overland moves. The duration of these impacts would be short-term, ranging up to five months, and recovery would vary from one to several years. Some impacts from snow machines and ATVs, on trails with continuous use, such as near villages, could be major (but localized) and would not recover as long as the traffic continues.

Impacts to wetlands and floodplains from oil and gas exploration would occur from seismic work, construction of ice roads and ice pads and construction of well cellars during exploratory drilling. The duration and recovery time for impacts associated with seismic work would be similar to those for overland moves. Based on earlier studies, there would be no substantial, long-term impacts to wetlands and floodplains from seismic lines, but camp move trails could substantially impact approximately 1,490 acres after 8 to 9 years. Effects of well cellar construction would also be long-term, but would impact less than 0.4 acre of vegetation.

The effects of oil and gas development and operation would include destruction of wetlands during construction of gravel pads (central processing facilities or gas compressor facilities, satellite drill pads, pump stations, and staging bases), roads, and airstrips, from excavation of material sites and burial of gas pipelines, and construction of vertical support members. These impacts would be long-term and would impact about 9,902 acres of the NPR-A. Plant communities could also be altered by dust deposition, salinity of gravel fill used in construction, snowdrifts, and blockage of or change to natural drainage patterns. These long-term impacts would affect approximately 29,301 acres. Spills of oil, other chemicals, and saltwater could occur and would have long-term impacts, except for those associated with small-size spills, which would be cleaned up immediately, allowing recovery within a few years to two decades.

The potential for many shallow streams, ponds, and wetlands in the Arctic to dry out under a warming climate would increase from the loss of permafrost. These shallow systems depend on snowmelt as their primary source of water, with rainfall gains often negated by evapotranspiration during the summer. Evaporation from these shallow waterbodies is very likely to increase as the ice-free season lengthens. Hence, the water budget of most lake, pond, and wetland systems is likely to depend more heavily on the supply of spring meltwater from winter precipitation to produce a positive annual water balance, and these systems are more likely to dry out during the summer (Arctic Climate Impact Association (ACIA) 2004).

Climate change could alter species composition, increasing the prevalence of deciduous shrubs and decreasing the prevalence of wetland sedges and grasses, and could greatly influence wetlands through hydrological changes. Warmer soil temperatures are likely to increase thermokarst and increases in sea level may inundate low-lying tundra areas increasing aquatic and wet tundra vegetation types and increase erosion of coastal bluffs (ACIA 2004). Such impacts of climate change could accelerate or exacerbate changes in soil thermal regimes that occur with oil and gas development potentially leading to greater and/or cumulative impacts (Walker et al. 1987) to wetlands from changes associated with thermokarst.

Because of the different exploration and development scenarios for each alternative, the potential for short-term impacts to wetlands in terms of areal extent under Alternative A would be about 39 percent more than Alternative B-1, 29 percent more than Alternative B-2, 24 percent less than Alternative C, and 30 percent less than Alternative D. The potential for long-term impacts to wetlands in terms of areal extent under Alternative A would be about 32 percent more than Alternative B-1, 18 percent more than Alternative B-2, 33 percent less than Alternative C, and 39 percent less than Alternative D.

4.3.7 Fish

4.3.7.1 Activities Not Associated with Oil and Gas Exploration and Development

For the majority of non-oil and gas activities in the National Petroleum Reserve-Alaska (NPR-A) that are part of Bureau of Land Management (BLM) operations or authorizations, refined petroleum spills would be the prevalent concern for potential impacts on fish. Small camps (for research, guided recreation, or guided hunting) would have cooking fuel and occasionally other fuels for generators, motorboats, and aircraft. Refueling motorboats and floatplanes would be particularly susceptible to spills in water. However, only small caches (up to 210 gallons) of any fuel would be permitted to be stored within 500 feet of the active floodplain of any waterbody and would require adequate containment. Larger caches (over 210 gallons) would have to be sited beyond the setback of 500 feet and would similarly require containment. Large camps could have as much as 5,000 gallons of fuel in a bladder or solid storage tank and operations of that magnitude would require a spill-prevention and response plan and have cleanup supplies on site. Small spills of fuel or industrial fluids could also leak from vehicles and equipment traveling over land in the winter for supply deliveries to villages or for solid and hazardous waste removal and remediation. Additionally, large volumes of fuel (over 3,000 gallons) are sometimes transported during the supply deliveries, and this would require appropriate containment and a spill prevention and response plan, as well. The effects of petroleum spills on fish are discussed in section 4.3.7.2, "Effects of Oil Spills and Gas Releases."

Non-oil and gas activities could cause other potential impacts to fish during winter operations. Projects related to waste removal and remediation could require extensive winter infrastructure, such as snow trails, ice roads, ice pads (for camps), ice airstrips, and personnel camps requiring water use and waste handling. Winter overland moves to supply villages typically only utilize snow trails. Environmental protective measures would be the same as those for winter oil and gas operations. The possible effects of these winter activities on fish are described in the sections starting on pages 147 and 149.

Scientific research (including pre-development projects by industry) on lakes, streams, and rivers in the NPR-A could also affect fish. Some projects would involve the capture and handling of fish, which can lead to fish injury or mortality even with proper techniques. Intentional removal of individual fish could also occur to collect biological information (e.g., maturation stage, age) or generate other data (e.g., isotope analysis, contaminant levels).

4.3.7.2 Oil and Gas Exploration and Development Activities

The following discussion addresses the potential effects of oil and gas activities on freshwater, anadromous, and marine fish and fish habitat found within the NPR-A under Alternative A.

Effects of Seismic Surveys

Seismic surveys can utilize dynamite (or other explosives), air guns, or Vibroseis to generate acoustical energy pulses necessary to locate subsurface geological formations that might contain oil or gas. Research has demonstrated that high-intensity acoustic energy can lead to damaged auditory sensory hair cells in fish, effectively reducing the ability to hear (McCauley et al. 2003; Popper 2003; Smith et al. 2004; Popper et al. 2005). The extent of damage and the ability to regenerate these cells is dependent on the intensity and duration of noise and the species of fish. Underwater shock waves can also cause injury to the swim bladder and other organs and tissue (Wright 1982), which could result in a sub-lethal or lethal effect. However, acute mortality from acoustic energy may be a problem primarily associated with explosive-based sources (Wright 1982; Cott et al. 2003). Fleeing behavior is also a well-documented response by fish to anthropogenic sounds (Popper 2003; Popper et al. 2004).

Before potential impacts on fish were strongly considered, dynamite-based seismic surveys could be conducted directly over lakes during the winter, for example, during the 1974 and 1975 surveys on Teshekpuk Lake. In 1991, Alaska Department of Fish and Game (ADF&G) established blasting standards (Alaska Department of Fish and Game 1991) that limit the power of explosives that can be used in close proximity to fish-bearing waters. This effectively banned the use of dynamite directly within or over waterbodies. Seismic surveys using explosives in Alaska since that time have been subjected to these empirically derived blasting standards, which provide substantial protection to fish at all life stages.

During ice-free periods, the collection of seismic data in aquatic areas could be accomplished using watercraft outfitted with air guns as the sound source. Because the air gun array is configured to focus sound toward the bottom, effective source levels for sound propagation in the horizontal direction are lower than those below the array. In water, injury and death of organisms exposed to seismic energy largely depends on two features of the sound source: (1) an extremely high, received peak pressure, and (2) a relatively short time for the pressure to rise and decay (Wardle et al. 2000). Considering the peak pressure and rise/decay time characteristics of seismic air gun arrays used today, the zone in which fish and invertebrates would be harmed should be within a few feet of the seismic source. The frequency of air gun pulses that an organism is exposed to would also be a factor affecting the magnitude of the impact.

As described above, the potential impacts of air gun arrays on fish include stress from fleeing behavior and physical damage or death. Although food resources for regaining lost energy reserves are more readily available for fish in summer than in winter, and eventual mortality from energy expenditure is less likely, numerous exposures to a sound disturbance could divert time away from important behaviors such as feeding or predator avoidance. In one case where habituation was studied, normal behavior resumed soon after passage of the array (Chapman and Hawkins 1969). However, other cases found evidence that, due to a prominent fleeing response, the use of seismic air guns can lead to lower catch rates of fish in a localized area, at least for several days (Engas et al. 1996; Engas and Lokkeborg 2002). Air gun-caused damage to auditory sensory cells in fish is documented (McCauley et al. 2003), and may be the greatest non-lethal concern regarding the use of this technology. A few studies have looked at mortality from seismic pulses on various life stages of fish (reviewed by Turnpenny and Nedwell 1994). In general, the studies indicate that fish eggs and larvae would suffer mortality at zero-peak noise levels of 220 decibels. These levels occur only at distances of up to 4 to 10 feet from air guns used during seismic exploration, and some mortality of eggs, larvae, or juveniles could occur up to about 18 feet below large sub-arrays. Adult fish only suffer mortality at received levels of 240 decibels, which occur at distances of less than 3 feet from an air gun. Since it is likely that nearly all fish would move to avoid the passage of the seismic boat, fish would rarely be present close enough to an air gun to be killed (Davis and Thomson 1999), although eggs and larvae would still be vulnerable.

Stipulation K-3b would provide protection to some biologically sensitive areas concerning air gun-based seismic surveys. Under this stipulation, oil and gas exploration operations such as air gun-based seismic surveys are restricted in Dease Inlet, Admiralty Bay, and Elson Lagoon between May 15 and October 15 each year, which encompasses the open-water period.

Vibroseis, the standard method for seismic surveys in the NPR-A, only occurs during the winter months. However, much of the research related to the impacts of noise on fish has been conducted using airgun arrays, explosives, or long-term background noise (Popper et al. 2004). Because of a lack of information regarding the impacts on fish from Vibroseis specifically, winter field tests were conducted in 2000, to measure the sound pressure levels in water that were generated by Vibroseis rigs operating on the ice overhead (Greene 2000; Nyland 2002). The results indicated that these sound pressures were great enough 10 meters from the source to cause avoidance behavior, but no measurements were made directly below the Vibroseis equipment. In order to obtain the needed measurements and to experimentally expose fish to Vibroseis noise, the Alaska Department of Natural Resources, Office of Habitat Management and Permitting, in consultation with the BLM, North Slope Borough, community members from Barrow and Nuiqsut, and WesternGeco, conducted an additional winter study in 2003 with Vibroseis rigs operating on ice above caged fish (Morris and Winters 2005). No mortalities were observed, and there was no indication of damage to swim bladders, muscle tissue, or blood vessels. The observed eye injuries were likely a result of fish swimming into the side of the holding cage during a flight response. Auditory sensory cells were not examined.

Fish fleeing behavior was the most obvious effect of Vibroseis during the 2003 Alaska Department of Natural Resources/BLM study (Morris and Winters 2005). Because exploration using Vibroseis occurs in the winter when physiological stress is the greatest for most fish species, a flight response could potentially be detrimental. However, fish wintering in a river or small lake would probably only be exposed to Vibroseis noise once as the seismic train traveled overhead. In this scenario, it is not likely that the response to a single sound event would cause eventual mortality; although the magnitude and intensity of the response observed in the 2003 study indicates that multiple exposures to Vibroseis noise during a winter season merits concern. This could occur over larger bodies of water where multiple shots may be required.

In addition to the potential effects on fish from acoustical energy, there are also concerns regarding possible impacts to fish habitat related to seismic vehicles traveling across the landscape during winter. However, these potential effects are largely mitigated by required operating procedures. Vibroseis surveys occur when most waterbodies are considerably frozen, with operations only beginning once snow cover and ground frost are sufficient to protect the tundra, as specified in Required Operating Procedure C-2. Required Operating Procedure C-3 provides protection to stream banks by requiring that waterway crossings be made at a low-angle. It also mandates that any snow or ice bridges across stream channels be breached before spring break-up to avoid blocking fish migrations and that operators travel a minimum of 100 feet from known fish overwintering habitat (see pages 147 and 159 regarding spring fish migrations and overwintering habitat). To further protect fish overwintering areas, Required Operating Procedure C-4 prohibits travel up and down streambeds (unless it is demonstrated that no impacts will occur to overwintering fish) and requires that rivers and streams be crossed at shallow riffles whenever possible. Risks to water quality from petroleum products and waste associated with seismic vehicles and camps are minimized by Required Operating Procedures A-2, A-3, A-4, and A-5. These required operating procedures address the handling of potential pollutants, as well as requiring prevention and spill response planning.

Under Alternative A, effects of seismic surveys on freshwater, anadromous, or marine fish should be localized, and they primarily impact individual fish in a specific lake or other overwintering location. It can be assumed that the more miles surveyed under any given alternative, the greater the probability that effects on fish may occur. The incidence of impacts on fish occurring from seismic surveys would be the least under Alternative A (54,178 surveying miles). It would be 7 percent less than Alternatives B-1 and B-2, 24 percent less than Alternative C, and 30 percent less than Alternative D.

Effects of Snow Trails, Ice Roads, Ice Pads, and Ice Airstrips

Winter operations (other than seismic) in the NPR-A are conducted by industry for exploratory drilling as well as plugging and abandonment of exploratory wells. Temporary infrastructure may include snow trails, ice roads, ice pads (for drilling and camps), and ice airstrips. Water use necessary for constructing ice infrastructure is addressed in "Effects of Water Demand" on page 149.

Potential effects on fish habitat related to ice roads and snow trails are largely the same as those for seismic vehicles traveling cross-country in the winter. Petroleum products or other industrial fluids could leak from vehicles and equipment using these routes, compromising water quality when the snow and ice melt in the spring. This is mitigated by Required Operating Procedures A-3, A-4, and A-5, as discussed above. Similarly, the risk of damaging streambanks is reduced by Required Operating Procedure C-3. However, concerns related to affecting overwintering fish habitat and impeding fish migrations during spring break-up are greater for snow trails and ice roads than cross-country seismic operations. Snow trails and ice roads more commonly require reinforced "bridges" (made from ice and/or snow) across stream channels and typically have greater traffic across channels.

Locating winter transportation "bridges" where water will freeze to the bottom under normal winter conditions is preferred, as specified by Required Operating Procedure C-4. However, if placed above overwintering habitat out of necessity, the increased ice thickness associated with these crossings will result in a reduction of habitat where conditions may already be marginal. This can have a negative impact on fish, unless the under-ice water is substantially deep and expansive, as with the Colville River ice bridge that is built annually to connect the Alpine Oil Field with the Kuparuk area. Overwintering habitat is critical for fish in the Arctic, as it has been estimated that by late winter ice formation can decrease available habitat in rivers and streams by approximately 97 percent (Craig 1989a). A marked reduction in overwintering habitat at a given location would lead to increased fish densities, and overcrowding can increase stress, deplete oxygen supplies, and increase the concentration of metabolic byproducts to a point that may be fatal to the fish (Schmidt et al. 1989).

Once streams and rivers begin to thaw in the spring, increased ice thickness and density at snow trail or ice road channel crossings can cause the "bridges" to remain intact longer than the surrounding ice and create a potential impediment to fish movements (Whitman et al. 2011). For example, most mature arctic grayling make an upstream spawning migration prior to occupying feeding habitat and the timing of this migration is strongly associated with ice break-up (Tripp and McCart 1974; Armstrong 1986; Blackman 2002; Morris 2003). Grayling behaviors observed during the migration include swimming under the ice and congregating in areas well before ice conditions allow free passage (Tack 1980; Beauchamp 1990). Delayed access to spawning habitat or increased energetic demand could affect spawning success of grayling. Fleming and Reynolds (1991) found that many grayling, particularly females, continued to mature during a spawning-run delay. The results of the study indicated that the delay lead to premature spawning during the run, with individuals failing to make it to preferred upstream areas. If downstream areas are of lesser quality, effects could be carried over to the next year because arctic grayling spawn in their natal areas (Hop and Gharrett 1989).

Instream barriers could also affect other Arctic fish attempting to migrate from overwintering areas to feeding habitat during the early part of the open-water season. Many broad whitefish move upstream during break-up to access productive feeding habitat (Bond and Erickson 1985; Chang-Kue and Jessop 1992; Morris 2003; Morris et al. 2006). In some cases, this includes taking advantage of the opportunity to reach locations only accessible during spring flooding (Lugas'kov and Stepanov 1988). Humpback whitefish and least cisco have been documented making similar upstream migrations early in the open-water period (Alt 1979; Bond and Erickson 1985). Given the common life history strategy of Arctic fish to utilize multiple habitats throughout the year (Craig 1984a, 1989a; Morris 2003; Moulton et al. 2007), other species may also be at risk if ice bridges create barriers. Energy reserves are already typically low for most fish and additional stress or delayed access to preferred habitats could have a detrimental impact. A barrier to movement could alter migration patterns to lower quality feeding habitat and increased energetic demands could compromise survival.

Although Required Operating Procedure C-3 requires that all snow and ice bridges "be removed, breached, or slotted before spring break-up," techniques for this are not standardized and results can vary in different hydrologic settings (Whitman et al. 2011). For example, if an ice bridge is narrowly slotted in the middle, water may channelize, and the resulting increase in water velocity may be too great for fish passage. Ineffective breaching can also lead to ice damming and impede upstream fish movements. Remnant ice bridges can impact habitat, as well, either by deflecting flow into streambanks or causing streambed scour. However, despite instances where these types of problems occur, since 2004 approximately 85 percent of slotted ice bridges observed during spring break-up have been evaluated as effectively meeting the objective of Required Operating Procedure C-3 (Whitman 2010).

Ice pads may be constructed to support exploratory drill rigs and work camps that include housing for personnel, bulk fuel storage, and domestic services such as waste and wastewater handling. Although liquid spills from mechanical operations associated with exploratory drilling and work camps could compromise local water quality, Required Operating Procedures A-3, A-4, and A-5 reduce the risk by setting handling, prevention, and response standards for hazardous materials. Further mitigation of water quality risks from exploratory drilling is provided by A-2, which requires that all pumpable waste be injected and that mud and cuttings be stored only temporarily until they are used to facilitate injection or backhauled, and A-6, which prohibits the surface discharge of reserve-pit fluids. Lease Stipulation D-1 also protects aquatic habitat by restricting exploratory drilling in rivers, streams, and fish-bearing lakes. In the Northeast NPR-A, the stipulation outright bans drilling in these waterbodies, but in the Northwest NPR-A, there are allowable exceptions. The potential effects of using large amounts of water for the exploratory drilling process are discussed in the section called "Effects of Water Demand" on page 149. Domestic services required for work camps are regulated by A-2, which provides guidelines for disposal of wastewater. Finally, with an ice pad ranging in probable size from 3 to 10 acres, it is unlikely that it will drastically alter flow patterns to an extent that would affect fish, unless the pad was positioned in an extremely small catchment.

Ice airstrips built to support winter operations can be built terrestrially or on large lakes. Building an ice airstrip on land requires large quantities of water (see "Effects of Water Demand" on page 149), similar to the ice road process. Creating an airstrip by scraping the snow off of a frozen lake should not impact overwintering fish habitat as long as an area of the lake is utilized that would naturally freeze to the bottom. Required Operating Procedure B-2 would only allow compaction or removal of snow from an area of grounded ice.

Under Alternative A, effects on freshwater, anadromous, and marine fish from snow trails, ice roads, ice pads, and ice airstrips, and the associated activities that take place on this temporary infrastructure, such as vehicle travel, industrial equipment transport and use, exploratory drilling, and supporting work camps, would likely be localized to a number of discrete locations. Across different alternatives, the anticipated length of ice roads and snow trails is a reasonable relative index of potential effects on fish from winter oil and gas activities. The greater the transportation network, the more supporting infrastructure and associated activities. From this perspective, the expected incidence of impacts on fish from winter oil and gas activities Alternative A (77,240 ice road/snow trail miles) would be 40 percent more than Alternative B-1 and 30 percent more than Alternative B-2, but 25 percent and 29 percent less than those under Alternatives C and D, respectively.

Effects of Water Demand

Water is required in winter for building ice roads, ice pads, and ice airstrips, supporting work camps, and drilling exploratory wells. As described earlier in the section discussing those topics (page 147), habitat in rivers and streams available for overwintering is significantly limited (Craig 1989a). Because waterbodies typically freeze to about 5 to 6 feet in depth during winter (Baker 2002; Hinzman et al. 2006; Hilton et al. 2009), water depths of approximately 7 feet are considered the minimum for supporting overwintering freshwater fish. However, some lakes 5 to 7 feet in depth do not freeze entirely to the bottom and provide limited overwintering habitat for some fish species that can tolerate more extreme conditions. The limited amount of available overwintering habitat may be the single most important factor affecting Arctic fish population size and cyclical fluctuations in abundance (Craig 1989a; Reynolds 1997). For example, competition for limited overwintering space has been suggested as a major cause of population fluctuations in North Slope broad whitefish stocks (Gallaway et al. 1997).

Required Operating Procedure B-1 prohibits winter water withdrawals from rivers and streams to protect the limited overwintering habitat in channels. Water withdrawals are allowed from lakes in the winter, as guided by rules in Required Operating Procedure B-2, which closely follows current policy developed by Alaska Department of Fish and Game. This policy sets limits for withdrawal based on maximum depth and fish species present, although flexibility is allowed for site-specific decisions. If an exception is made to permit more water than is normally allowed from a particular lake, additional in-season monitoring is required. Because little science existed earlier in the decade to help evaluate the relatively new limits for water use that are outlined in Required Operating Procedure B-2, a number of investigations in Arctic Alaska and Canada were initiated to examine water levels and water chemistry in relation to pumping activities.

Lowered lake water levels can affect total winter habitat space, summer accessibility, and habitat characteristics (such as littoral zone size), and ultimately reduce survival (Heman et al. 1969; Gaboury and Patalas 1984). In the existing areas of oil exploration and development on the Arctic coastal plain, lakes pumped solely for winter exploration activities have recharged in the spring (Streever et al. 2001; URS 2001; Baker 2002; Baker 2007; Holland et al. 2008). This includes lakes where ice chips were utilized in addition to permitted free-water volumes (Baker 2007). Furthermore, although there is some indication that winter water withdrawals can reduce the amount of dissolved oxygen available for fish (Cott et al. 2008a), changes are not apparent at current levels of withdrawal on the North Slope (Hinzman et al. 2006; Chambers et al. 2008). Natural lake properties in the Arctic have been the best predictors of oxygen depletion during the winter, rather than pumping (Chambers et al. 2008). Nevertheless, despite effective guidelines, overpumping events have occurred on lakes in the past, due to misidentification of specific lakes in the field and poor recordkeeping.

Year-round water use occurs to support permanent domestic facilities and waterflooding of production wells. Waterflooding is a process that can increase oil recovery by injecting water into selected areas of the reservoir to maintain subsurface pressure and promote fluid flow up to the surface, which requires vast amounts of water (e.g., approximately 760 million gallons per year; see "Waterflooding" on page 37). Although freshwater may be used, local sources would unlikely be able to meet the demand, and it also must be chemically treated before being injected. As such, seawater is the preferred source due to the indefinite supply and the fact that is does not require treatment. While this can be efficient for development near the Arctic Ocean coast, it will be more problematic for inland development.

Limitations on freshwater use from lakes during ice-free periods would still be guided by Required Operating Procedure B-2. However, concerns about effects on fish would be much less during this time period. For example, dissolved oxygen is typically near saturation during open-water periods due to very frequent wind mixing (Moulton et al. 2010a, MJM Research 2004a). Reduced water levels would still be a concern, particularly as it relates to connecting a lake to other lakes or streams.

One potential issue surrounding seawater use for waterflooding is the number of anadromous or marine fish that might be entrained by the intake device. Seawater intakes are constructed with ports fronted by a concrete wall that descends from the surface of the water to a depth of 23 feet. These ports are designed to exclude ice from being entrained, but their presence also means that fish must pass under the 23-foot-deep barrier to reach the intake ports. Low-velocity intakes are fitted with filter and diversion screens to prevent fish from entering (Dames and Moore 1985). Monitoring at the Prudhoe Bay and Kuparuk waterflood facilities from 1984 to 1987 found that few fish entered the bypass system and most that did were able to pass through (Dames and Moore 1985, 1986, 1987, 1988). Nevertheless, an exception was observed in 1985 when more than a million fish larvae of nine species were entrained at the Prudhoe Bay facility (National Research Council 2003).

Despite the problem in 1985, monitoring halted after 1987 when the intakes were determined to be largely functioning as intended. If seawater intake facilities were constructed in the future to enhance supply to oil fields in the NPR-A, it is assumed that additional safeguards using newer and more efficient technology would be incorporated to prevent the entrainment of fish. Seawater pipeline spills related to waterflooding operations are addressed on page 152.

Regardless of the time of year, intake screens are also required in all freshwater sources, as mandated in Required Operating Procedure B-2. These screens must be approved by Alaska Department of Fish and Game Division of Habitat, which has developed specifications that significantly limit water velocity around the structure. This design has proven effective in numerous lakes over several years, although a few isolated incidents have occurred where small fish have been killed or injured by getting caught in the intake screen.

Considering the protective guidelines under Alternative A, as described above, and the number of studies investigating both freshwater and seawater uses, effects of water demand on freshwater, anadromous, or marine fish should be limited to local, short-term impacts. In evaluating all alternatives, the relative comparison of projected ice infrastructure should be directly related to the expected incidence of impacts on fish from winter water use. Consequently, Alternative A (326,684 acres of ice pads, ice airstrips, and ice roads/snow trails) should have an incidence of impacts that is 40 percent greater than Alternative B-1, less than 1 percent greater than Alternative B-2, 25 percent less than Alternative C, and 33 percent less than Alternative D. The more production pads anticipated under an alternative, the greater the need for year-round freshwater for personnel camps. The degree of foreseeable impacts on fish from year-round domestic freshwater demand under Alternative A (103 oil and gas production pads) should be 37 percent more than Alternative B-1, 26 percent more than Alternative B-2, 30 percent less than Alternative C, and 36 percent less than Alternative D. The year-round need for seawater for waterflooding would be proportional to the number of oil production pads that would exist for an alternative. The probable extent of potential impacts on fish from year-round seawater use under Alternative A (16 oil production pads) would be 14 percent more than Alternative B-1 and B-2, 7 percent more than Alternative C, and the same as Alternative D.

Effects of Gravel Mining

Oil field development requires gravel for pads, roads, and airstrips. Gravel mining outside of floodplains would be preferable and would not affect fish. However, with the scarcity of gravel deposits in the NPR-A, most likely sources are within streams and floodplains. Sand and gravel mining within stream channels and active floodplains can impact channel structure (e.g., upstream headcutting, downstream channel incision), increase turbidity and sedimentation, and cause shifts in invertebrate communities, which can degrade local fish habitat conditions and modify fish species suitability (Kanehl and Lyons 1992; Meador and Layher 1998). Channel incision (i.e., bed lowering) can lead to subsequent channel widening (reducing pool habitat), contribute to further increases in sediment loads through streambed and streambank erosion, and cause landscape-level impacts by lowering base flow in tributaries (Shields et al. 1994). In one case study, channel incision from instream gravel mining exposed buried gas pipelines and bridge piers downstream (Kondolf 1997).

Increased sedimentation and turbidity can reduce algal and invertebrate productivity, diminish feeding success and cause displacement of visual feeders (e.g., arctic grayling), degrade spawning habitat, and reduce egg/embryo survival (Bjornn and Reiser 1991; Waters 1995; Henley et al. 2000). Because geomorphic impacts are so well documented, instream mining is banned in many European countries (Meador and Layher 1998).

Since gravel spawning areas are limited within the Arctic coastal plain of the NPR-A, there may be an association between these sites and optimal gravel-extraction sites, increasing the probability that spawning grounds could be impacted. For example, the Clover A Mine Site is within a small tributary to the Ublutuoch River. The narrow Ublutuoch River contains the only extensive reaches of gravel in the entire Fish Creek watershed, and is likely used for spawning by arctic grayling and other fish species. While Clover A is approximately a half mile from the Ublutuoch River, channel incision has been observed more than 6 miles downstream from an instream mine (Kondolf 1997).

A positive effect can result when abandoned floodplain gravel mines are flooded by a stream, effectively creating deep pools suitable for fish overwintering and spawning, and this has been well documented around current North Slope oil developments (Hemming 1988; Hemming et al. 1989; Roach 1993; ADF&G 2011b). Mine site development and rehabilitation would strongly consider this a benefit to fish populations (Alaska Department of Fish and Game 2011b) and follow the procedures outlined in North Slope Gravel Pit Performance Guidelines (McLean 1993). Site reclamation could potentially include constructing or enhancing access channels from surrounding streams and rivers.

Required Operating Procedure E-8 requires that gravel mine site design and reclamation be approved by the authorized officer. Gravel mine planning would occur in consultation with other appropriate federal, State, and North Slope Borough agencies. In addition to this multi-agency review, regulatory roles by other agencies should help mitigate potential effects of gravel mining on fish. For example, the aforementioned Ublutuoch River is documented in the Anadromous Waters Catalog (Alaska Department of Fish and Game 2011a; Alaska Department of Fish and Game Anadromous Waters Catalog Map) as supporting anadromous fish and would be subject to additional protections under Alaska Statutes 16.05.871.

Considering the well-understood impacts associated with instream and floodplain gravel mining and regulations associated with this activity, negative effects on freshwater, anadromous, or marine fish under Alternative A would likely be localized to small drainages where gravel pits are constructed. Foreseeable potential impacts on fish due to gravel mining would be proportional to the maximum number of gravel pits expected under each alternative. Therefore, impacts under Alternative A (40 gravel pits or less) would be 38 percent more than Alternative B-1, 29 percent more than Alternative B-2, 23 percent less than Alternative C, and 27 percent less than Alternative D.

Effects of Development Pads, Roads, Airstrips, and Pipelines

A wide variety of potential effects on fish could occur from development pads, roads, airstrips, and pipelines related to oil and gas development. Associated activities, such as vehicle and equipment traffic, personnel camps, and production drilling, also have the capacity to impact fish. Potential effects from pads, roads, and airstrips are related to runoff patterns, runoff content, and stream crossings. For pipelines, there are fish concerns regarding stream crossings, oil spills and gas releases, and maintenance. Oil spills and gas releases are discussed separately in section 4.3.7.2, "Effects of Oil Spills and Gas Releases." The construction phase for this permanent infrastructure would largely occur during the winter months. Possible effects on fish from winter construction activities would be the same as those described in the sections starting on pages 147 and 149.

Improper placement of pads, roads, and airstrips could affect runoff patterns by eliminating, diverting, impeding, or constricting flow from small tributaries that connect rivers, streams, and lakes. Altered water flow characteristics could interfere with fish migrations to and from overwintering, spawning, and feeding grounds. This could be particularly adverse to many Arctic fish that rely on multiple seasonal movements to optimize habitat suitability at various life-history stages (Morris 2000; Morris 2003; Bond and Erickson 1985; Strange 1985). An objective of Required Operating Procedure E-6, which addresses stream and marsh crossings, is to reduce the potential for altering natural drainage patterns. Impervious surface areas, such as pads and roads, can also increase flood intensity and reduce baseflow (Klein 1979; Leopold 1994; Moscrip and Montgomery 1997; Whitman 2002), which can affect fish survival (Nawa and Frissel 1993; Bradford et al. 1995; May et al. 1997). A watershed response threshold to impervious surfaces has been observed at approximately 10 to 12 percent imperviousness (Klein 1979; Schueler 1994). With the projected maximum surface cover of a hypothetical joint oil development complex at 174 acres, typical impacts associated with impervious surface coverage would only be anticipated in small catchments that are less than 1,740 acres. Required Operating Procedure E-5 contributes to minimizing impervious surfaces by encouraging a reduced development footprint.

Runoff content is potentially affected by vehicle and equipment traffic on pads, roads, and airstrips, personnel camps on pads, and production drilling on pads. Petroleum products and mechanical fluids could leak from vehicles and equipment and compromise water quality. Traffic or natural weathering and erosion processes could cause increased stream turbidity and sedimentation, depending upon materials used in constructing and surfacing pads, roads, and airstrips (see "Effects of Gravel Mining" on page 151 for effects of turbidity and sedimentation on fish). On pads, water quality concerns are related to handling wastewater from personnel camps and produced fluids from drilling. Potential impacts on fish from oil spills that could originate at production wells are discussed in section 4.3.7.2, "Effects of Oil Spills and Gas Releases." Effects of pollutants on fish include increasing sensitivity to diseases (Tarazona and Munoz 1995), reducing tolerance to fluctuating temperatures (Becker and Wohlford 1980), blocking senses important to foraging, predator avoidance, and imprinting (Stone and Schreck 1994), decreasing survival (Petukhov and Storozhuk 1980; Hamilton and Wiedmeyer 1990), and reducing the abundance of invertebrate prey (Dickman and Rygiel 1998). The risk of increased pollutant concentrations from vehicle and equipment use or personnel camps is reduced by Required Operating Procedures A-2, A-3, A-4, A-5, and Lease Stipulation E-2. Required Operating Procedure A-7 restricts discharge of fluids produced from the oil-development phase.

Since roadway stream crossings can cause barriers to fish movements, Required Operating Procedure E-6 mandates that stream and marsh crossings ensure free passage of fish and emphasizes that bridges, rather than culverts, are the preferred method for channel crossings. Culverts are permitted if it is determined that they will not restrict fish passage, but despite efforts to construct adequate culverts in many places, these structures, which can be obstructed during periods of either high or low stream flow, are still often problematic for fish movements (Elliot 1982; Furniss et al. 1991; Warren and Pardew 1998). Recent investigations into stream-crossing structures in the North Slope oil fields found a number of crossings had problems that likely impair or impede fish passage beyond the structures (Morris and Winters 2004, 2007). Barriers to movement could force fish to utilize less suitable habitat for spawning and feeding, as discussed previously, and could also impact demographics of local fish populations (Harvey and Railsback 2011). The additional hydrology and fish studies required by Required Operating Procedure E-14 should help engineers determine the appropriate structures to install at stream channel crossings to reduce impacts on fish.

Lease Stipulation E-2 limits pipelines within 500 feet of fish-bearing waterbodies, and pipelines would generally be routed to circumnavigate lakes, although a number of foreseeable stream crossings would be required due to the vastness of the region. For either oil or gas, narrow streams could be crossed using elevated pipelines on suspension spans. Wider, shallow rivers could be crossed by trenching and burying insulated pipelines in the riverbed. Entrenched crossings would be constructed in the winter at locations, which would avoid or minimize disturbances to overwintering fish habitat. Pipelines suspended over streams should have no effect on stream habitat and flow characteristics as long as they are located at a high enough elevation to avoid flooding (Fogg and Hadley 2007). Buried pipelines can cause channel degradation and scour if not effectively engineered (Fogg and Hadley 2007). Effects on fish due to increased turbidity and sedimentation from scour are the same as those discussed in the section “Gravel Mining” on page 151.

Pipelines are used to transport seawater to inland facilities for waterflooding in addition to oil and gas delivery. A leak in a seawater pipeline could potentially spill highly saline water into freshwater habitat. Depending upon salt concentration, duration of exposure, water temperature, and other variables, an increase in salinity can influence a variety of physiological responses in fish (Griffiths et al. 1992; Altinok and Grizzle 2001; Jia et al. 2009). In general, different species have variable salinity tolerances and this can strongly influence the composition of fish assemblages (Matthews 1998; Williams 2001; Higgins and Wilde 2005). Seawater pipelines would be subjected to similar restrictions and guidelines and could cause similar impacts as those described above for oil and gas pipelines.

Maintenance activities for aboveground pipelines could require off-road travel in some areas where they are set back or distant from roads. Potential effects of winter travel operations on fish for this purpose would be the same as those described in “Effects of Snow Trails, Ice Roads, Ice Pads, and Ice Airstrips,” and those for summer tundra travel are described on page 156. The use of floating booms on streams during the summer to capture any oil that might spill from a pipeline should not inhibit fish passage or affect geomorphology, as these are used successfully in current North Slope oil fields on State lands. Required repairs on pipelines buried under streams could also be expected. Unless requiring immediate attention, maintenance and repairs of buried pipelines could occur during winter to minimize potential effects on fish.

Several K lease stipulations under Alternative A would provide additional protection to some biologically sensitive areas from development infrastructure. K-1 establishes half-mile, three-quarter-mile, and 1-mile development setbacks from a number of major rivers (except in deltas), predominantly on the coastal plain. Permanent oil and gas facilities would be prohibited within these setback areas, except for essential road and pipeline crossings. Similarly, K-2 establishes a quarter-mile development setback from deep water lakes, defined as those greater than 4 meters, which comprise lake zone IIII (Mellor 1985; Map 3.3.10-1). However, while K-2 also restricts permanent facilities except essential road and pipeline crossings, it allows that any facility can be considered on a case-by-case basis. For the Northeast Planning Area, K-3a prohibits any permanent facilities with a quarter mile of Teshekpuk Lake, with no exceptions for roads and pipelines. Finally, under K-8b, no development infrastructure would be permitted within the Kasegaluk Lagoon Special Area.

Under Alternative A, development pads, roads, airstrips, and pipelines, and associated activities such as vehicle and equipment traffic, personnel camps, and production drilling, should cause impacts to fish in different areas at a small catchment scale. However, those impacts would not be expected to have a significant effect on larger watershed populations of freshwater, anadromous, or marine fish in the NPR-A or adjacent waters. The anticipated length of roads and pipelines is representative of the relative scale of expected development under each alternative. From this standpoint, the incidence of impacts on fish from those structures and associated activities under Alternative A (2,281 miles of roads and pipelines) would be 20 percent more than Alternative B-1, 11 percent more than Alternative B-2, 40 percent less than Alternative C, and 42 percent less than under Alternative D. The incidence of impacts on fish related to gravel pads and airstrips under Alternative A (155 gravel pads and airstrips) would be 37 percent more than Alternative B-1, 28 percent more than Alternative B-2, 27 percent less than Alternative C, and 32 percent less than Alternative D.

Effects of Causeways

The construction of solid gravel causeways along the coast has long been a sensitive fisheries issue (U. S. Army Corps of Engineers 1980, 1984). These structures can extend several miles out to sea and are used for year-round seawater extraction, and as docking facilities for seaborne supply. They have the potential to physically block fish moving along the shore and/or alter coastal circulation and mixing patterns, such that hydrographic conditions become inhospitable for anadromous and marine fish. The nearshore coastal zone is an important summer feeding location and migration pathway for many fish species. Studies conducted at Prudhoe Bay have documented some instances in which causeways have altered, impeded, and completely blocked fish from migrating along the coast (Fechhelm 1999; Fechhelm et al. 1989, 1999). These structures can also alter physical habitat by changing the dynamics of natural sediment transport in river deltas (Yager 2011).

The BLM discourages the use of solid-fill causeways, preferring instead alternatives such as onshore directional drilling, elevated structures, or buried pipelines. Lease Stipulation E-3 prohibits the construction of causeways, docks, artificial gravel islands, and bottom-founded structures in river mouths and deltas, and the construction of artificial gravel islands and bottom-founded structures in active stream channels. If any such structures were approved, they would be designed, sited, and constructed in a way meant to prevent large changes in nearshore hydrography and maintain free passage of marine and anadromous fishes. Additionally, a monitoring program would be required to evaluate water quality and fish passage.

Marine vessel activity associated with a causeway, or a similar structure such as a dock, could result in further effects on fish. Regardless of the type of structure utilized for a port, vessel traffic would tend to be concentrated at that location. The increase in underwater noise level associated with these vessels could cause some fish species to disperse from the local area (Gutreuter et al. 2006; Slabbekoorn et al. 2010) and affect acoustic communication between other fish species that remain (Codarin et al. 2009).

Under Alternative A, causeways or any other structures that extend into coastal waters could impact anadromous or marine fish along local coastline areas. Under the different alternatives, susceptibility to causeway effects can be based on the estimated length of coastline within available leasing areas for each alternative (Table 4-19 on page 162). From this perspective, 100 percent of the NPR-A coastline (approximately 1,200 miles) would be vulnerable to causeways under Alternative A, which would be the same for Alternative D. Comparatively, causeways could potentially be built along less than 10 percent of coastline under Alternative B-1 and B-2, and 50 percent of coastline under Alternative C. However, under Alternatives A, B-1, and C (Lease Stipulation K-8b), Kasegaluk Lagoon would be off-limits to permanent oil and gas facilities, while under Alternatives D and B-2 a causeway or similar structure could be constructed there.

Effects of Summer Tundra Travel

The potential impacts on fish from summer tundra travel with low-ground-pressure vehicles would include sedimentation and degraded water quality. If vehicles cross streams, increased sedimentation could occur from streambank damage and disturbance of the streambed, and small leaks from equipment (e.g., fuel or mechanical fluids) could degrade water quality. However, the case-by-case evaluation for permitting this type of travel under Required Operating Procedure L-1 would provide the opportunity to avoid sensitive areas (e.g., known spawning grounds). If future summer tundra travel in the NPR-A is similar in magnitude to what currently takes place in North Slope oil fields on State lands, impacts would be infrequent and short-lived.

Under Alternative A, limited summer tundra travel could affect freshwater or anadromous fish in a number of discrete lakes and streams, but would not likely have any impact on marine fish. Since most approved summer tundra travel would be related to pipeline maintenance, the length of pipelines estimated for each alternative is indicative of the relative extent of potential effects on fish from this activity. Accordingly, the expected incidence of impacts under Alternative A (1,580 miles of all pipelines) would be 13 percent more than Alternative B-1, 5 percent more than Alternative B-2, 45 percent less than Alternative C, and 45 percent less than Alternative D.

Effects of Oil Spills and Gas Releases

Oil spills have been observed to have a range of effects on fish, depending on the concentration of petroleum present, the length of exposure, and the stage of fish development. Eggs, larvae, and juveniles are the most sensitive (Malins 1977; Hamilton et al. 1979; Starr et al. 1981). Although initial fish mortality can occur at lethal concentrations, effects of sublethal concentrations can also ultimately lead to mortality (Carls et al. 1999; Carls and Rice 1990; Peterson et al. 2003). Sublethal effects in fish can include morphological deformities, genetic damage, reduced growth, and impaired fitness (e.g., swimming ability) (Carls et al. 1999; Hose et al. 1996), as well as an increase in the occurrence and magnitude of parasitism (Kahn and Kiceniuk 1988; Kahn 1990). Since spilled oil typically reaches sediments (Teal and Howarth 1984), spawning success can also be impacted. Due to a number of individual or confounding effects, local fish density and biomass can decline (Barber et al. 1995). The persistence of spilled oil in bottom substrates compared to the water column additionally influences overall effects on fish, as littoral-zone species may recover faster than benthic species (Collier et al. 1996).

One critical factor affecting the ultimate impacts of oil spills on fish is the timing of the spill. Stream flow in the NPR-A begins in late May to early June as a rapid flood event that can inundate extremely large areas. While this could spread spilled oil, it could also create a flushing effect and reduce contaminant concentrations in waterbodies. Spills during the open-water period would more frequently place fish at greater risk than times of ice-cover. With snow and ice present from 8 to 9 months a year, spills are typically much easier to contain and clean up. On the contrary, if spilled oil does enter a liquid water source under the ice, the ability to clean it up effectively is lost, and evaporation, weathering, and other degradation processes will not occur until the ice melts.

The location of an oil spill also significantly influences the effects on fish. For example, a spill may persist for longer within a lake than a stream due to a much greater residence-time for water and other fluids, but a spill in a stream could likely impact a larger geographic extent. Spills occurring farther upstream in a watershed also place more freshwater habitat at risk than those that occur in lower reaches or along the coast. Similarly, spills along or near the coast would likely disperse and degrade faster due to increased water volume, currents, and wind. However, if oil from a spill along the coast remains in the water when it begins to freeze, it may be pushed upstream into rivers during the winter due to saltwater intrusion, which is well documented in the lower Colville River (Seigle et al. 2011). Finally, as described in the section “Large Crude Oil Spills” on page 82, the fate and behavior of spilled oil will be strongly influenced by a number of local factors such as stream geomorphology, water and air temperature, and ice cover, among others.

In addition to timing and location, oil spill size is the third critical factor influencing effects on fish. As described in the NPR-A Oil Spill Analysis on page 81, for the purpose of this EIS, oil spills are analyzed based on three spill-size categories: (1) small (less than 500 barrels), (2) large (from 500 up to 120,000 barrels); and (3) very large (120,000 barrels and over). Effects of very large oil spills on fish are discussed in section 4.11.4.7 in Volume 4. Most small Alaskan North Slope industry spills have been contained on gravel pads and roadbeds (National Research Council 2003), where cleanup is relatively easy, effectively eliminating potential impacts on fish. Other small spills, presumably associated with pipeline leaks, are more prone to reach the environment and potentially contaminate aquatic habitat. Regardless of the source, large spills would have a much greater likelihood of impacting fish. Although the GC-2 spill from a pipeline (5,054 barrels) was limited to approximately 2 acres, other large spills could be much greater in size (up to 120,000 barrels). Large spills with the most potential to negatively impact fish would be those that initiate from water vessels (e.g., barges) or pipelines, especially those within stream channels or floodplains. The duration of impacts from a large spill that reached aquatic habitat would be considerably longer than from a small spill.

The location of a gas release is the primary concern regarding possible effects on fish. If a gas line buried under a stream ruptured, a small number of fish in the immediate vicinity might be killed, depending upon the pressure of the release. Displacement to less suitable habitat could occur, as well. Although some water-soluble gas condensates can be harmful to fish (Mahon et al. 1987), produced gas in the NPR-A is expected to be dry (no water or condensates). Gas releases from a production pad, processing facility, or terrestrial pipeline would not affect fish.

While the timing of oil spills and gas releases would be largely attributed to chance, required operating procedures and lease stipulations include requirements and guidelines for locating pads, roads, and pipelines, and associated refueling operations that reduce the risk of spills or gas releases entering fish habitat. The E-2 Lease Stipulation requires that permanent oil and gas facilities and infrastructure be more than 500 feet from ordinary high water marks, with essential pipeline and road crossings evaluated on a case-by-case basis. Under Required Operating Procedure A-5, equipment refueling within 500 feet of the active floodplain of any waterbody is prohibited, and fuel storage exceeding 210 gallons must also be outside of this setback.

Other required operating procedures should help reduce the size of oil spills and gas releases that do occur. Provisions for required impermeable containment, spill prevention, and response planning are included in Required Operating Procedures A-3 and A-4. Additionally, Required Operating procedure E-4 necessitates that pipelines be built and operated with the best available technology for detecting and preventing corrosion or mechanical defects.

Several K lease stipulations under Alternative A would provide additional protection to some biologically sensitive areas from oil spills and gas releases. K-1 establishes half-mile, three-quarter-mile, and 1-mile development setbacks from a number of major rivers (except in deltas), predominantly on the coastal plain. Permanent oil and gas facilities would be prohibited within these setback areas, except for essential road and pipeline crossings. Similarly, K-2 establishes a quarter-mile development setback from deep water lakes, defined as those greater than 4 meters, which comprise lake zone IIII (Mellor 1985; Map 3.3.10-1). However, while K-2 also restricts permanent facilities except essential road and pipeline crossings, it allows that any facility can be considered on a case-by-case basis. For the Northeast Planning Area, K-3a prohibits any permanent facilities with a quarter mile of Teshekpuk Lake, with no exceptions for roads and pipelines. Finally, under K-8b, no development infrastructure would be permitted within the Kasegaluk Lagoon Special Area.

Under Alternative A, effects on freshwater, anadromous, or marine fish from small crude or refined oil spills and from any gas release should typically be localized. Most gas releases would only present an acute, short-term threat to fish, whereas impacts from liquid (oil and other produced fluid) spills would be much greater. Since most Alaskan North Slope industry spills have been contained on gravel pads and roads (National Research Council 2003), pipeline leaks would be the most likely source for spills that could affect fish. Consequently, the estimated extent of pipelines that would transport liquids under each alternative represents a practical relative risk to fish from small spills. The risk under Alternative A (1,350 miles of pipeline for oil and two- or three-phase produced fluids) would be 28 percent more than Alternative B-1, 16 percent more than Alternative B-2, 45 percent less than Alternative C, and 46 percent less than Alternative D.

Effects on fish from large oil spills, if a substantial portion reached freshwater, could impact freshwater and anadromous fish populations at a watershed level. If a considerable quantity of a large oil spill reached coastal waters, this could potentially impact anadromous or marine fish populations. However, this would largely depend on the time of year due to temporal variability in fish use along the coastline. For example, early in the open-water season many anadromous and coastal marine fish migrate to feed in the particularly productive nearshore waters (Craig 1984a), while fewer fish are likely present along these coastal areas by late fall when feeding is no longer optimal and salt concentrations begin to increase under the ice. The percent chance of one or more large oil spills (Table 4-16) under Alternative A (37 percent) is more than Alternative B-1 (28 percent) and B-2 (30 percent), the same as Alternative C (37 percent), and less than Alternative D (39 percent).

Effects of Abandonment and Reclamation

Abandonment and reclamation of oil and gas development areas would include removing pads, roads, culverts, bridges, pipelines, and associated facilities, efforts to reestablish vegetation, and possibly reconfiguring gravel pits. Lease Stipulation G-1 only provides broad guidance for oil and gas field abandonment, requiring that the final disposition of the land must meet the current and future needs of the public. Surface disturbance related to the removal of permanent infrastructure could increase turbidity and sedimentation in nearby waters. The effects of turbidity and sedimentation on fish are described in the section called "Effects of Gravel Mining" on page 151. If fertilization is conducted as part of reestablishing vegetation, increased nutrient concentrations in runoff (especially phosphorous) to lakes and streams could lead to eutrophication and excessive algal growth (Carpenter 2008; Narasimhan et al. 2010). Mild nutrient increases can lead to greater algal and invertebrate productivity, which can be transferred to fish (Deegan and Peterson 1992; Peterson et al. 1993), but more advanced nutrient loading (i.e., eutrophication) can reduce dissolved oxygen, influence fish reproductive success and susceptibility to disease, cause food web shifts that affect fish species suitability, and contribute to fish mortality (Snieszko 1974; Willemsen 1980; Pihl 1994). As described in the section on gravel mining, additional fish habitat could be created by connecting gravel pits to nearby streams.

Effects (negative or positive) on freshwater, anadromous, or marine fish from oil and gas abandonment and reclamation under Alternative A should only occur at individual lakes, small stream reaches, or limited coastline areas. The total area of surface disturbance under the different alternatives should reflect the relative magnitude of potential effects on fish from abandonment and reclamation. As such, Alternative A (16,577 acres of permanent pads, roads, pipelines, and gravel pits) would have an expected incidence of impacts that is 24 percent more than Alternative B-1, 12 percent more than Alternative B-2, 39 percent less than Alternative C, and 42 percent less than Alternative D.

4.3.7.3 Effectiveness of Stipulations and Required Operating Procedures

The required operating procedures and lease stipulations under Alternative A would mitigate potential impacts on fish from oil and gas activities to the extent that effects would likely occur in localized areas and only a large oil spill would be expected to potentially affect fish at the population level. Required Operating Procedures A-2 through A-7 reduce risks to water quality impairment through procedures for handling potential pollutants, preventing spills, and responding to spills. These are largely based on current practices that have worked well in recent exploration activities and in oil and gas development areas to the east of the NPR-A. Water-use guidelines in Required Operating Procedures B-1 and B-2 correspond with current standards utilized by Alaska Department of Fish and Game that have resulted in few impacts as demonstrated by a number of investigations.

Similarly, based on recent field evaluations, winter stream channel crossings have largely met the objectives outlined in Required Operating Procedures C-3 and C-4. Lease Stipulations D-1, E-2, K-1, K-2, K-3a, K-3b, and K-8b collectively address the location of exploration and development activities with regard to aquatic resources. Although only speculative, in principal these setbacks should be effective in reducing the incidence of foreign materials (e.g., sediment or pollutants) reaching surface waters. Required Operating Procedures E-4 and E-5 further strengthen the protections provided by these setbacks by requiring that the best available current technology be used to reduce the extent of infrastructure and minimize pipeline spills.

Other required operating procedures aim at avoiding impacts when infrastructure placement is necessary within or in close proximity to fish habitat. Guidance to prevent roads from affecting fish passage at stream crossings is outlined in Required Operating Procedures E-1, E-6, and E-14, which mandate site-specific hydrology and fish studies, and that crossing structures be built according to best known practices. Required Operating Procedure E-8 requires that gravel mines be developed in a manner that would consider effects of current and past North Slope gravel mines, and Lease Stipulation E-3 prohibits the building of causeways or similar structures that would restrict free passage of anadromous and marine fish, which did occur in Prudhoe Bay in the past. Finally, while Lease Stipulation G-1 mandates abandonment and reclamation following oil and gas development, it is unknown whether this would be an effective practice to minimize or remove impacts on aquatic habitats.

4.3.7.4 Conclusion

As described above in detail, the potential impacts to freshwater, anadromous, and marine fish from oil and gas exploration and development activities within the NPR-A under Alternative A broadly include acoustic disturbance, injury at water-use intakes, altered water quality, physical habitat changes (water quantity, flow patterns, and geomorphology), point and non-point source pollution, increased turbidity and sedimentation, and barriers to fish movements. These impacts can collectively contribute to reduced success at different life history stages, behavioral changes, diminished condition, susceptibility to pollutants or disease, shifts in fish species distribution, and mortality. The required operating procedures and lease stipulations in Alternative A and the corresponding best management practices and lease stipulations in the other alternatives would essentially provide the same level of protection to fish. The major exception is that Alternative D has no comparable provisions to Lease Stipulations K-3a and K-3bin Alternatives A, B-1, B-2, and C and Alternatives D and B-2 have no comparable provision to Lease Stipulation K-8b in the other alternatives.

The fundamental difference among the various alternatives regarding potential effects on fish is the extent of land that would be open for leasing to conduct oil and gas activities and the distribution of those lands within the NPR-A Fish Habitat Units (Map 3.3.4-1; Table 4-19). Under Alternative A, NPR-A lands available for leasing include 17,800 miles of potential stream habitat. This is 9 percent more than Alternative B-1, 3 percent more than Alternative B-2, 30 percent less than Alternative C, and 48 percent less than Alternative D. The amount of potential lake habitat within lands that may be leased in Alternative A (1,624,000 acres of lake surface area) is 61 percent more than Alternative B-1, 62 percent more than Alternative B-2, 2 percent less than Alternative C, and 14 percent less than Alternative D. The distribution of these waterbodies in different NPR-A Fish Habitat Units is described in Table 4-19.

If predicted shifts in physical and chemical characteristics of the environment occur with climate change (e.g., Scenarios Network for Alaska Planning 2010), impacts on fish from oil and gas activities under Alternative A could be greater or less than expected. The magnitude of shifts in these habitat characteristics will ultimately determine this. Responses to habitat change will also vary for different fish species, which can have diverse physiological tolerances and life history behaviors. For example, if water temperatures increase excessively, metabolic stress for many fish species would be greater and result in lower tolerance thresholds to land-use impacts. On the other hand, a moderate increase in water temperature could contribute to a more productive feeding season and enable fish to better survive the winter and additional stress from oil and gas activities. Future hydrologic patterns will strongly influence fish habitat conditions, as well, but the trajectory of these patterns is unclear. Decadal scale analyses of high-latitude lakes have shown variable results, with lake abundance and surface area decreasing in some areas and increasing in others (Smith et al. 2005; Hinkel et al. 2007; Jones et al. 2009; Marsh et al. 2009). Similarly, the duration and timing of stream-lake connectivity is shown to be shifting in opposing directions in various places in the Arctic (Woo and Guan 2006; Lesack and Marsh 2007). Those hydrologic aspects could either alleviate or exacerbate land-use pressures on fish (e.g., lake water use). A change in the timing and quantity of water flow could also contribute to fish passage problems at stream channel or wetland road crossings that are designed based on past flow regimes.

Table 4-19. Potential aquatic habitats susceptible to impacts from oil and gas activities based on available leasing areas in different alternatives[A]

NPR-A Fish Habitat Unit	Acres Total Surface Area Within NPR-A [B]	Acres Available for Leasing [B]	Percent Area Available for Leasing [C]	Within Area Available for Leasing		
				Stream Miles [B]	Number of Lakes (>10 acres)	Surface Area Acres Lakes (>10 acres) [B]
Alternative A						
Lower Colville	1,128,200	1,128,200	100	3,400	615	31,400
Mountain Headwaters	4,201,000	22,200	1	0	10	300
Coastal Plain	8,986,800	8,714,400	97	9,900	14,356	1,548,500
Foothills	4,673,900	2,576,300	55	4,100	304	15,600
Utukok/Kokolik	3,126,700	266,000	9	400	326	28,200
Coastal Marine	428,600	428,600	100	(Coastline Length 1,200 miles) [B]		
Alternative B-1						
Lower Colville	1,128,200	1,128,200	100	3,400	615	31,400
Mountain Headwaters	4,201,000	531,400	13	900	26	600
Coastal Plain	8,986,800	5,764,400	64	6,400	9,160	916,900
Foothills	4,673,900	2,795,200	60	4,500	316	17,700
Utukok/Kokolik	3,126,700	730,300	23	1,100	410	42,900
Coastal Marine	428,600	5,000	1	(Coastline Length <100 miles) [B]		
Alternative B-2						
Lower Colville	1,128,200	1,128,200	100	3,400	615	31,400
Mountain Headwaters	4,201,000	539,000	13	900	27	600
Coastal Plain	8,986,800	6,467,000	72	6,600	9,324	903,400
Foothills	4,673,900	3,385,000	72	5,300	376	23,200
Utukok/Kokolik	3,126,700	733,000	23	1,100	408	42,900
Coastal Marine	428,600	5,000	1	(Coastline Length <100 miles)[B]		
Alternative C						
Lower Colville	1,128,200	1,128,200	100	3,400	615	31,400
Mountain Headwaters	4,201,000	791,100	19	1,400	41	1,300
Coastal Plain	8,986,800	8,697,900	97	9,800	14,343	1,547,100
Foothills	4,673,900	4,673,900	100	7,200	403	24,700
Utukok/Kokolik	3,126,700	2,072,000	66	3,800	501	46,900
Coastal Marine	428,600	34,700	8	(Coastline Length 600 miles)[B]		

Table 4-19. Potential aquatic habitats susceptible to impacts from oil and gas activities based on available leasing areas in different alternatives[A]

NPR-A Fish Habitat Unit	Acres Total Surface Area Within NPR-A [B]	Acres Available for Leasing [B]	Percent Area Available for Leasing [C]	Within Area Available for Leasing: Stream Miles [B]	Within Area Available for Leasing: Number of Lakes (>10 acres)	Within Area Available for Leasing: Surface Area Acres Lakes (>10 acres) [B]
Alternative D						
Lower Colville	1,128,200	1,128,200	100	3,400	615	31,400
Mountain Headwaters	4,201,000	4,201,000	100	7,700	328	14,700
Coastal Plain	8,986,800	8,986,800	100	9,900	14,397	1,758,500
Foothills	4,673,900	4,673,900	100	7,200	403	24,700
Utukok/Kokolik	3,126,700	3,126,700	100	5,900	581	49,700
Coastal Marine	428,600	428,600	100	(Coastline Length 1,200 miles)[B]		

A. BLM-managed lands only; surface area, stream, and lake calculations from National Hydrography Dataset.

B. Rounded to the nearest hundred.

C. Rounded to the nearest whole number.

4.3.7.5 Potential Mitigation Measure (new required operating procedure)

Objective: Minimize the effects of high-intensity acoustic energy from seismic surveys on fish.

Requirement/Standard:

a. When conducting vibroseis-based surveys above potential fish overwintering areas (water 6 feet deep or greater, ice plus liquid depth), operators shall follow recommendations by Morris and Winters (2005): only a single set of vibroseis shots should be conducted if possible; if multiple shot locations are required, these should be conducted with minimal delay; multiple days of vibroseis activity above the same overwintering area should be avoided if possible.

b. When conducting air gun-based surveys in freshwater, operators shall follow standard marine mitigation measures that are applicable to fish (e.g., Minerals Management Service 2006): operators will use the lowest sound levels feasible to accomplish their data-collection needs; ramp-up techniques will be utilized (ramp-up involves the gradual increase in emitted sound levels beginning with firing a single air gun and gradually adding air guns until the desired operating level of the full array is obtained).

c. When conducting explosive-based surveys, operators shall follow setback distances from fish-bearing waterbodies based on requirements outlined by Alaska Department of Fish and Game (1991).

Potential Benefits and Residual/Unavoidable Impacts: This potential new mitigation measure would clarify that the most current protective management recommendations regarding high-intensity acoustic energy associated with seismic surveys would be applied to operations in or near fish-bearing waters. The benefit to fish from Vibroseis guidelines would be a further reduction in the likelihood that flight responses would lead to eventual mortality. Without this measure, Vibroseis-based surveys over fish overwintering areas could expose fish to more disturbance than necessary. Some disturbance-induced flight responses would still take place and physiological impacts (e.g., to auditory sensory hair cells) could potentially occur (see section 4.3.7.2, "Effects of Seismic Surveys"). While most air gun use has occurred in marine environments, it has become more common to use this technology in rivers and lakes in the Canadian Arctic (Song et al. 2008; Jorgensen 2009). As described by the Minerals Management Service (2006), although ramp-up procedures were developed to protect marine mammals, this practice would also benefit some fish. Limiting sound levels and utilizing ramp-up procedures would reduce the potential for fish injury or mortality. In the absence of this measure, a greater number of fish would be at risk due to excessive sound levels and lack of a warning to disperse. Regardless, different fish species have variable sensitivity to sound and demonstrate a range of avoidance reactions (Minerals Management Service2006), indicating that ramp-up procedures would be more effective at driving away some fish than others. Also, eggs, larvae, or other small fish incapable of swimming away would be potentially damaged or killed in close proximity to an air gun (Turnpenny and Nedwell 1994). Ramp-up procedures would allow diving birds to be warned, as well, and disperse before being subjected to underwater air gun pulses (Minerals Management Service 2006). Coastal and offshore marine use of air guns would be subject to even stricter operating procedures under the jurisdiction of the Bureau of Ocean

Energy Management and under the authority of the National Marine Fisheries Service and the Fish and Wildlife Service as related to the Marine Mammals Protection Act. Setback distances from fish-bearing waterbodies required by Alaska Department of Fish and Game (1991) for explosive-based activities intend to effectively eliminate impacts to fish at all life stages. Even without this proposed new best management practice, operators would still have to follow these protocols in the NPR-A. However, its inclusion here clarifies the BLM's endorsement of the regulations. These requirements are unlikely to incur additional expense to industry of a level that would result in less seismic exploration.

4.3.8 Birds

This section discusses the potential direct and indirect effects to non-special status bird species that could result from management actions in the NPR-A under Alternative A; a discussion of effects to threatened and sensitive bird species is given in section 4.3.11.2, "Special Status Species." Approximately 90 species of birds commonly or regularly occur in the NPR-A. Most of these species, including loons, waterfowl, shorebirds, raptors, passerines, and seabirds, are migratory and occur in the planning area only during the breeding season which can span the period of June through September. Most of the activities that could potentially affect birds in the NPR-A would result from oil and gas exploration, development, and transport. Other activities that could potentially affect birds include permitted recreation, guided hunting, activities associated with scientific surveys and research camps, cleanup of oil and gas exploration sites, and activities associated with government actions (e.g., cleanup of abandoned well sites). These activities could affect tundra-nesting birds by causing: (1) habitat loss, (2) disturbance or displacement, (3) increased predation, and (4) direct mortality. Impacts would most often be localized and on the scale of individual birds. Impacts have potential to have greater negative effect if the activity occurs in an area of high bird density (such as near lakes containing large numbers of molting geese or shorebird nesting or staging areas) or in areas containing populations of species known to have declining populations or those particularly sensitive to disturbance.

Alternative A would make available approximately 57 percent (13 million acres) for oil and gas leasing of the NPR-A's approximate 22.8-million subsurface acres (Map 2-1). Four Special Areas containing 8.3 million acres would be allocated. Under Alternative A, all of Teshekpuk Lake including its islands and virtually all of the Goose molting area (an area which also supports the highest densities of nesting shorebirds that have been documented along the entire Arctic Coastal Plain of Alaska along with very high nest survivorship) north and east of the lake would be deferred from leasing. However, the deferred lands near Teshekpuk Lake would be available for leasing after the expiration of the deferral on July 16, 2018. Permanent oil and gas facilities, with the exception of pipelines, would be prohibited in two areas important to nesting shorebirds and the movement of caribou around Teshekpuk Lake and in a 5- to 6-mile band around the southern portion of the Goose molting area (Map 2-1T). A large area of land in the western most section of the NPR-A, including the Kasegaluk Lagoon Special Area and lands near Wainwright, would be deferred from leasing until 2014. In addition, stipulations have been designated under this alternative that would help to mitigate potential negative impacts that could result from the various activities(see Table 2-4 for a complete list of stipulations).

4.3.8.1 Activities Not Associated with Oil and Gas Exploration and Development

Ground camps associated with non-oil and gas activities include both small and large groups of people involved in scientific research, permitted recreation, and guided hunting. These camps range in size from small mobile parties that remain at a site for only a day to larger camps that are operated for periods of up to 12 weeks. The majority of seasonal camps would operate during the summer. Various types of disturbances could affect birds located near summer camps. Noise and ground activities may disturb birds, causing temporary or permanent displacement from preferred habitats, and potentially affecting energy budgets and productivity of individuals. Although pedestrian traffic has been shown to be particularly disruptive to some waterfowl and raptors (Roseneau et al. 1981; Ritchie 1987; Johnson et al. 2003b), some birds may also acclimate to predictable daily activities of camp personnel. Winter camps are not often used, but when employed would most likely be located on previously disturbed areas. There are relatively few birds present in the NPR-A in the winter, so disturbance from winter camps would likely be minimal.

Aircraft activity to mobilize and re-supply summer camps may disturb birds along flight corridors and near airstrips. Effects of this type of visual and noise disturbance could range from temporary displacement from preferred habitats to nest abandonment. Fixed-wing and helicopter flights would be intermittent, and could occur several days or weeks apart. It may be easier for birds to acclimate to flights that occur on a regular basis than to flights that occur on a more random basis (Johnson et al. 2003). Birds could also suffer mortality due to collisions with aircraft. Ward et al. (1999) studied response of brant to fixed-wing and rotary-wing aircraft and reported that 75 percent of brant flocks showed a change in activity (response) due to overflights, with more flocks responding to rotary-wing (51 percent) than to fixed-wing (33 percent) aircraft. Responses to overflights occurred up to 1,219 meters (4,000 feet) in altitude and a lateral distance to 4.8 kilometers (3 miles), although the majority of birds responded to aircraft that were within a lateral distance of 0.8 kilometer (½ mile) or less (Ward et al. 1999). The greatest response to aircraft occurred at altitudes between 305 and 762 meters (1,000 and 2,500 feet). Birds nesting near summer camps could suffer mortality or egg loss from predators attracted to anthropogenic sources of food or human presence at camps. Nest abandonment could occur if nests are located in areas with high levels of activity. In all alternatives, the following required operating procedures would mitigate the potential negative effects of activities associated with all non-oil and gas activities requiring BLM authorization as mentioned above: Required Operating Procedures A-1 through A-7, F-1, and L-1 would apply to all alternatives while Stipulation K-7 would apply to all alternatives except Alternative D. Impacts would likely be localized and restricted to within about a mile of activities at the camp.

Summer boat traffic could occur on the Colville, Kogosukruk, Kikiakrorak, Kuk, Mead, Utukok, Inaru, Ikpikpuk and other rivers for permitted recreation, guided hunting, or to establish or re-supply camps located along these rivers. Numerous studies have reported on the effects of boat disturbance to birds (e.g., McGarigal et al. 1991; Steidl and Anthony 1996). Boat activity and associated human presence could potentially affect nesting gyrfalcons, arctic peregrine falcons, and rough-legged hawks along river corridors. The current levels of boat activities on these rivers have apparently not impacted raptors negatively, as some populations, particularly the arctic peregrine falcon population; have been increasing on the Arctic Coastal Plain in recent years (Ritchie et al. 2003). Fuel spills due to summer boat traffic are expected to be small (less than 5 gallons), and would most likely occur during fuel transfers. Fuel spills of this type have very little potential to negatively impact birds as the amount is so small. Although, if a spill occurs in areas where the birds are feeding (contamination of prey items) or if fuel comes into contact with and adheres to the birds' feathers some effect to individual birds may occur. Any such losses would negatively impact individuals and would not be likely to have an effect at the population level. The following required operating procedures and stipulations contained in Alternative A would mitigate the potential negative effects of activities associated with the oil and gas exploration activities mentioned above: Required Operating Procedures A-1 through A-7 and L-1 and Stipulations K-7 and K-8.

Aerial surveys for wildlife in the planning area could include fixed-wing aircraft and helicopter surveys. Low-level fixed-wing aerial surveys would probably have only a short duration, low-level effect on birds due to the short amount of time during which aircraft would be within an individual's zone of disturbance. Ward et al. (1999) reported a decreasing level of response to aircraft overflights by brant with increasing lateral distance of aircraft. The majority of birds responded at lateral distances of 0.8 kilometer (½ mile) or less. Wildlife telemetry studies involving relocation of birds using radio telemetry could cause greater disturbance to birds by the take-offs and landings required for deploying ground personnel for attaching transmitters. Pedestrian traffic, necessary for transmitter attachment, has been shown to be more disruptive to some waterfowl species than other types of disturbance (Johnson et al. 2003b). The effects to birds from these activities could range from temporary displacement from preferred habitats to nest abandonment and loss of production for the breeding season. Required Operating Procedure F-1would mitigate the potential negative effects of activities associated with the oil and gas exploration activities mentioned above.

Cleanup activities at sites in the NPR-A that are not associated with oil and gas activities but require cleanup (e.g., military sites) may involve the use of fixed-wing aircraft or helicopters to access the sites. The effects of this traffic would be similar to those described above for mobilizing and re-supplying summer camps. Ground activity by workers on foot could be more disruptive to some bird species than other types of disturbance (Johnson et al. 2003b).

4.3.8.2 Oil and Gas Exploration and Development Activities

Exploration

Ground-based seismic surveys and other exploration activities would occur during the winter months when few birds are present in the NPR-A. Therefore, these activities would likely have no direct impacts on most species. A few species, including snowy owl, gyrfalcon, ptarmigan, and common raven, which could be present in the planning area during winter, may be temporarily displaced from preferred feeding areas by exploration activities. Support of seismic surveys and other exploration activities would include the use of both fixed-wing aircraft and helicopter. As so few birds are present in the planning area during the period when these activities would occur, it is very unlikely that aircraft traffic would cause more than a minor temporary disturbance to a few individual birds.

Acreage estimates, and thus, the potential for impacts to birds from seismic surveys varies by alternative, with Alternative A needing the fewest acres of seismic survey. Alternatives B-1, B-2, C, and D estimate increasing numbers of acres of seismic surveys (Table 4-11).

Rolligons and track vehicles used during seismic surveys could leave tracks on tundra habitats that would be observable for several years (Kevan et al. 1995). These tracks could affect vegetation, soil chemistry, soil invertebrates, and soil thaw characteristics—key components of bird habitats. The most noticeably affected areas would include terrain with considerable microtopographic relief caused by mounds, tussocks, hummocks, and high-centered polygons. Wet areas are less likely to be affected than dry areas (Walker 1996). Snow acts as a buffer against these impacts; therefore, avoiding areas with low snow cover, in addition to using lightweight vehicles, dispersing traffic patterns, and minimizing sharp turns, could help to minimize damage to vegetation and landforms used by birds (Walker 1996). Required Operating Procedures C-2 and C-4 would mitigate the potential negative effects of activities associated with the oil and gas exploration activities mentioned above.

The use of air guns for boat-based seismic work in Teshekpuk Lake and some coastal waters during the summer could temporarily displace loons, shorebirds, and waterfowl from preferred feeding habitats. Such a survey of Teshekpuk Lake, however, is unlikely under Alternative A, because the lake would not be available for leasing. Such surveys also would not occur from May 15 through October 15 in several large coastal bays and lagoons due to restrictions in Stipulation K-3b (Dease Inlet, Admiralty Bay, Elson Lagoon, and Associated Barrier Islands). Stipulation K-3b does not include Kasegaluk Lagoon and Peard Bay as those areas are deferred from activities until January 2014. After the deferral ends in 2014, Kasegaluk Lagoon and Peard Bay would not have the same protections as the areas covered by K-3b. Stipulation K-6 in Alternative A does not include Kasegaluk Lagoon or Peard Bay. Disturbance to birds may also result from boat activity associated with boat-based seismic surveys (Rodgers and Smith 1995). Individual birds could be displaced from preferred habitats by seismic activities, but it is likely that this displacement would be temporary and individuals would return after the air gun arrays passed through the area. Effects of use of air guns on forage fish may include stress from fleeing behavior and physical damage or death potentially resulting in a reduction in the amount of fish prey available to foraging birds. Disturbance to birds near and nesting on the shoreline could result from support activities, such as use of helicopters to transport personnel and supplies. Disturbance related to support activities could result in permanent or temporary displacement from nesting, feeding, staging, or brood-rearing habitats. Conducting seismic surveys after the completion of the nesting and brood-rearing period would eliminate the potential for nest abandonment and loss of productivity. Stipulations K-3 and K-8 would help mitigate the potential negative effects of activities associated with the oil and gas exploration activities mentioned above.

Winter oil and gas exploration activities could indirectly affect tundra-nesting birds during the summer breeding season. Ice roads, snow trails, ice runways, and ice-pads are used for transportation, storage, and operation of exploratory drilling equipment. Construction of these features could temporarily alter tundra habitats by compressing standing-dead vegetation or delaying the growth and development of vegetation due to protracted ice melt. The altered vegetation could reduce the amount of suitable habitat for nesting and foraging birds, but these impacts would likely be small and would likely persist for only 1 or 2 years (Walker et al. 1987a, b). Required Operating Procedures C-2 and C-4 would mitigate the potential negative effects of activities associated with the oil and gas exploration activities mentioned above. In areas where winter ice roads and ice pads are constructed annually, varying the location of the roads and pads and avoiding more sensitive areas (generally drier areas (Yokel et al. 2005)) as provided for in Required Operating Procedure C-2 could help reduce potential impacts to tundra vegetation, and thus, to bird nesting habitat.

In some cases, equipment could be stored on ice-pads specially designed and constructed to last through the summer and into the following winter. The tundra under the footprint of these ice-pads would be lost to birds during the course of the summer. Locating these summer ice pads in drier areas would help to reduce potential impacts to loons, waterfowl, and some shorebird species associated with wetter habitat types, but could increase the potential impacts to species that use upland habitats such as plovers and buff-breasted sandpiper. Existing gravel pads within the NPR-A could be used for storage of seismic and exploration equipment. Existing pads are described on page 10.

Water used in constructing ice roads and pads would be withdrawn from deep lakes in areas adjacent to the ice roads and pads. Winter water withdrawal could alter lake water levels and adjacent habitats, although flooding and recharge during spring break-up would likely minimize the potential for long-term effects (Rovansek et al. 1996). In the area of oil exploration and development closest to the NPR-A (Alpine oil field), pumped lakes have recharged in the spring at levels similar to unpumped lakes (Streever et al. 2001; URS 2001; Baker 2002). Results from these studies are likely transferable to other areas that have a high concentration of lakes; however, areas with sparse lakes will have different watershed dynamics that will require additional study. Lake recharge during spring would probably negate any negative effects on invertebrate and fish populations used for food by birds in the spring, though this has not been studied directly. The following required operating procedures would mitigate the potential negative effects of activities associated with the oil and gas exploration activities mentioned above: Required Operating Procedures B-1, B-2, and C-3.

Potential for food (e.g., garbage) and shelter associated with winter exploration activities could attract predators such as arctic fox and raven. If these predators experience increased survival due to anthropogenic foods, increased predation pressure on birds may result. Required Operating Procedures/Best Management Practices A-1 through A-7 and E-9 in all alternatives provide protection to birds from impacts of non-hazardous and hazardous materials associated with the exploratory drilling process, garbage, produced water, drilling muds and cuttings, and from spills of fuel, crude oil, and other liquid chemicals.

Under Alternative A, it is estimated that there will be a need for 30 oil exploration wells (ground disturbance of 180 acres in the short term and less than 1 acre in the long term; see Table 4-14) and 68 gas exploration wells (ground disturbance of 444 acres in the short term and less than 1 acre in the long term). Thirty oil and 68 gas delineation wells are also expected to be drilled from ice pads causing short-term ground disturbance of 180 and 408 acres, respectively; essentially, no long-term ground disturbance is anticipated. Of all the alternatives, Alternative A is expected to create the second lowest amount of surface disturbance with Alternative B-1 expected to cause the least surface disturbance (about 25 percent less than Alternative A). Alternatives C and D are expected to cause the greatest amount of surface disturbance from exploration activities.

Development and Production

Habitat Loss

Gravel mining and placement for constructing oil and gas field infrastructure (including the burial of gas pipelines) would cause loss of bird habitat. Potential changes in the vegetation community caused by burial of gas pipelines could also result in a loss of bird habitat. During construction of roads and pads, tundra covered by gravel, as well as tundra associated with gravel mine sites, would be lost to use by birds. This loss of habitat would continue through the duration of the operation of the development, and would be permanent unless habitat restoration measures were successfully implemented after abandonment of the oil and or gas infrastructure. The potential long-term impacts associated with habitat loss could be minimized by locating gravel roads, pads, airstrips, and mine sites away from areas with high concentrations of nesting, molting, or staging birds and areas that may be critical to species with declining populations. To mitigate potential negative effects of activities associated with the oil and gas development and production activities mentioned above, Alternative A includes: Stipulations E-2, G-1, K-2, K-3a and b, K-4, K-6, K-8, and K-11.

Under Alternative A, it is estimated that 12 central processing facilities will be needed for oil development (disturbance of 450 acres in the short and long term; see Table 4-14) and 27 production pads per central processing facility or gas compressor facility for gas development (disturbance of 270 acres in both the short and long-term; see Table 4-14). In conjunction with these facilities, there are other support structures, such as gravel production pads, gravel runways, in-field gravel roads, several types of pipelines, and other associated structures, that will also cause surface disturbances. Under Alternative A, during the production phase it is estimated that the gravel footprint (total long-term disturbance) would be 9,902 acres (Table 4-14). Of all the alternatives, Alternative A is predicted to create the third lowest amount of long-term surface disturbance with Alternatives B-1 and B-2 predicated to cause the least surface disturbance, and Alternatives C and D estimated to cause the most surface disturbance.

Some birds that may have nested at sites previously not covered by gravel would be displaced and may not be able to find suitable habitat for breeding. Others would likely move to adjacent areas to nest. Troy and Carpenter (1990) reported that at least some shorebirds displaced by winter gravel placement may nest in adjacent habitats in subsequent years, and Johnson et al. (2003b) reported that waterbirds nesting near the Alpine oil field that were displaced from nesting sites by gravel placement probably moved their nests to nearby adjacent habitats. In addition, there may be a functional loss of habitat in areas near roads and pads, if development-related disturbances preclude birds from utilizing these habitats. Impacts related to habitat loss may be more severe for species that have specific habitat requirements. Under Alternative A, this plan provides for a number of areas in which no permanent oil and gas facilities may be located, and many of these protected areas are considered to be of high value to birds (Stipulations E-2, G-1, K-2, K-3a and b, K-4, K-6, K-8, and K-11).

The goose molting area within the Teshekpuk Lake is considered to be very valuable for molting brant, and nesting ducks, geese, and shorebirds. Species using this area would be protected from impacts related to oil and gas development and production until the deferral expires in 2018. Teshekpuk Lake itself and the islands within the lake would not be available for leasing through the life of the Plan (i.e., until a new decision is issued), protecting nesting and feeding areas for many species of birds. The Kasegaluk Lagoon Special Area is deferred from leasing until 2014, protecting high-density nesting habitat until expiration of the deferral for a variety of shorebirds and waterbirds (geese, ducks, and loons) and for several waterbird species that are taken in large numbers by subsistence hunters. This deferral also protects high-use migration and fall staging area for waterbirds including king eider, brant, and a variety of shorebird species. The Colville River Special Area provides a number of protections to birds, specifically raptors, including Stipulations E-15 and K-7. Therefore, the number of birds displaced from important habitats due to gravel placement and mining activities under Alternative A may be lower than under Alternatives C and D, although they would be greater than those under Alternatives B-1 and B-2. However, the actual effects of habitat loss under any alternative would depend on the location of the development, the types of habitat lost, and the level of bird use in the areas to be developed.

In addition to permanent habitat loss, temporary loss of habitat associated with gravel placement could occur on tundra adjacent to gravel structures, where accumulated snow from snow-plowing activities or snowdrifts would become compacted and lead to a delayed snowmelt. Delayed snowmelt persisting into the nesting season could preclude tundra-nesting birds from nesting in those areas. Delayed melt resulting from the construction and use of ice roads and snow trails during winter activities could also cause temporary habitat loss. Ice roads could also cause compaction of vegetation, thereby reducing the availability of cover for nesting birds in the ice road footprint. Potential impacts to tundra-nesting birds from ice roads may be reduced by alternating ice road routes annually and by avoiding routes near known areas of high bird concentration. Required Operating Procedure/Best Management Practice C-2 in all alternatives requires that ice roads be offset from year to year to minimize impacts to vegetation.

Water withdrawal from lakes during ice road construction could lower the level of lakes and affect waterfowl and shorebirds that use adjacent habitats, particularly small islands and shoreline areas that loons and waterfowl use for nesting. Changes in the surface levels of lakes due to water withdrawal would be dependent on the amount of water withdrawn, the volume of the lake, and the recharge rate. Required Operating Procedure/Best Management Practice B-2 in all alternatives places restrictions on the amount of water that could be withdrawn from individual lakes. In the existing area of oil exploration and development east of the NPR-A, pumped lakes have recharged in the spring at levels similar to unpumped lakes (Streever et al. 2001; URS Corporation 2001; Baker 2002). These observations are likely transferable to other areas that have a high concentration of lakes; however, areas with sparse lakes will have different watershed dynamics that will require additional study. In most cases, spring flooding during break-up would likely be sufficient to restore water levels (Rovansek et al. 1996). There is also potential for impacts to birds due to potential impacts to invertebrate and fish food resources from varying winter water levels if recharge does not fully recharge pumped lakes.

Dust deposition can affect bird habitat by causing early snowmelt, and thus, early green-up on tundra adjacent to roads and pads, which could attract waterfowl and shorebirds early in the season when other areas are not yet snow-free. Dust deposition could also increase thermokarst and soil pH, and reduce the photosynthetic capabilities of plants in areas adjacent to roads (Walker and Everett 1987; Auerbach et al. 1997). Ground and air traffic (including helicopters), and wind can influence the amount of dust that may be deposited adjacent to roads and pads. Troy (1988) reported higher densities of nesting birds on lightly dusted sides of roads in the Prudhoe Bay oil field than on heavily dusted sides, although red-necked phalarope was an exception to this generality. Rodrigues (1992) also reported that red-necked phalarope nest densities were higher on tundra near abandoned gravel pads than in areas away from pads, and suggested that phalaropes may be attracted to areas of thermokarst near the edges of gravel pads.

The melting of ice roads could be delayed compared to surrounding tundra, causing impoundments of water. Impoundments created by ice roads or gravel structures could be ephemeral (drying up early during the summer) and could cause temporary or permanent flooding on adjacent tundra, or they could become permanent waterbodies that would persist from year to year (Walker et al. 1987a, b; Walker 1996). Tundra covered by impounded water could result in a loss of nesting and foraging habitat for some birds. However, impoundments could also create new feeding and brood-rearing habitat that would be beneficial to some bird species. Noel et al. (1996) reported that the areas occupied by impoundments in the Prudhoe Bay area generally supported higher waterfowl densities than the same areas did prior to development. Kertell (1993, 1994) reported few differences in invertebrate numbers and numbers of Pacific loons when comparing use of natural ponds and impoundments in the Prudhoe Bay area. He also reported that ducks were more abundant on impoundments than natural ponds, although this difference was not statistically significant. The formation of impoundments could have relatively short-term (5 to 10 years) benefits to some species associated with nesting and brood rearing in association with water, provided the water level in the impoundment does not drop below the level necessary for successful completion of the breeding cycle. Impoundments that flood upland habitats could negatively impact species such as plovers and buff-breasted sandpiper that use dry upland habitats for nesting or courtship display. The effects of impoundments could be minimized or eliminated with culverts to allow for adequate cross-drainage at gravel structures. However, culverts blocked by snow or ice could prolong the spring flooding period (Walker 1996).

Bird mortality could also result from collisions with vehicles (ground and air) or structures such as elevated pipelines, buildings, drilling rigs, towers, power lines (if suspended), boats (including barges), or bridges. Along the Trans-Alaska Pipeline System, road kills were the greatest source of bird mortality, with the primary groups affected being grouse and passerines, particularly along the Dalton Highway where dust shadows caused early green-up along the road that attracted birds (Trans-Alaska Pipeline System Owners 2001). Although the number of birds killed was not quantified, the level of mortality was probably minor when compared to the size of local populations. Some bird mortality could also result from collisions with structures such as elevated pipelines, buildings, drilling rigs, towers, power lines (if suspended above ground), boats (including barges), or bridges. Birds are at risk of collisions with objects in their path, particularly when visibility is impaired during darkness or inclement weather (Weir 1976). The frequency of bird collisions with aircraft of the types used during oil and gas development and production are unknown and unstudied. Collisions seem to increase when objects are illuminated with constant diffuse light, and the tendency for birds to be drawn to diffuse light appears to increase during foggy or rainy weather (USDOI BLM 1999b, 1998). However, visibility is generally good during long summer daylight hours in the Arctic, and collisions have apparently been only a minor source of bird mortality associated with the Trans-Alaska Pipeline System (Trans-Alaska Pipeline System Owners 2001). Bird collisions with power lines in the Prudhoe Bay oil field have also been reported (Anderson and Murphy 1988). In all alternatives, Required Operating Procedure/Best Management Practice E-10 requires that structures shall be illuminated in ways proven to help reduce collisions of birds. Required Operating Procedure/Best Management Practice E-11 restricts the use of powerlines and placement of communications towers to reduce collision impacts to birds.

Disturbance

Activities related to oil and gas development and production in the NPR-A, such as vehicle, aircraft, pedestrian, and boat traffic, routine maintenance activities, heavy equipment use, and oil and gas spill cleanup activities could create disturbances that affect birds. These disturbances could result in temporary or permanent displacement from preferred habitats, potentially resulting in decreased nest attendance, nest abandonment, nest predation, and increased energy expenditures that could affect an individual bird's survival or reproduction. The likelihood for and severity of impacts to birds would vary, depending on the type, duration, and location of the disturbance; the species and number of individuals in the area; and the time of year. Impacts would be most likely to occur if facilities were located in habitats with high bird concentrations, in areas containing species that are vulnerable to small losses of nests, or in habitats that may be limiting for a particular species. Species of particular concern include red-throated loon, Sabine's gull, long-tailed duck, and buff-breasted sandpiper (Lanctot and Laredo 1994; Brown et al. 2000; Donaldson et al. 2001; Larned et al. 2006; Mallek et al. 2006).

In the North Slope oil fields, the types of disturbances listed above have been documented as occurring for waterfowl, and have been shown to have greater effects on greater white-fronted geese, Canada geese, and brant feeding close to roads than on geese feeding farther away from roads (Murphy et al. 1988; Murphy and Anderson 1993). Disturbances would be most prevalent during the pre-nesting period when birds gather to feed in open areas near roads, and during brood-rearing and fall staging when some geese exhibit higher rates of alertness in areas near roads than do birds in undisturbed areas (Murphy and Anderson 1993).

Some evidence suggests that pedestrian traffic may have a greater impact on some species of birds than vehicular traffic. During a study of the effects of disturbance related to the Lisburne Development in the Prudhoe Bay oil field, Murphy and Anderson (1993) reported that of the more common sources of disturbance, humans on foot elicited the strongest reactions from geese and swans. Johnson et al. (2003) determined that the highest rate of response to potential disturbance by nesting swans was to pedestrian disturbance. Ritchie (1987) reported that pedestrians caused greater disturbance to nesting raptors than other sources of disturbance. Johnson et al. (2003b) reported that aircraft and pedestrians elicited higher responses from nesting geese at the Alpine oil field than other sources of disturbance. Johnson et al. (2003) reported on a study conducted during construction and post-construction periods at the Alpine oil field in which they concluded that there was "individual variation in the responses of geese and swans to potential disturbance, and a reduction in response with increasing distance to the source, consistent with a gradient of exposure." Johnson et al. (2003) reported that for a sample of nesting geese at the Alpine oil field during the same study, airplanes and pedestrians caused the highest rates of response to disturbance and vehicles elicited the lowest rates of response. Troy (1988) reported that most common shorebird species occurred in lower densities near roads in the Prudhoe Bay oil field than in areas away from roads. This apparent avoidance of roads, however, may have been related to an avoidance of heavily dusted areas on tundra adjacent to roads with high traffic levels rather than an avoidance of vehicular activity itself. Disturbance from vehicular and pedestrian traffic could affect activity and energy budgets and have negative impacts on nest density and nesting success for some birds.

Nesting densities for many species of shorebirds are higher in areas near the coast compared to inland areas and disturbance that occurred in coastal areas may have a greater impact on shorebirds than inland disturbances. Restricting, reducing, and screening foot traffic on gravel roads and pads could also help to reduce the potential for disturbance. Waterfowl in general, seem particularly sensitive to disturbance during the flightless wing molt.

There appear to be species-specific responses to disturbance stimuli; with some species responding at lower stimulus levels and showing greater behavioral responses (Mosbech and Glahder 1991). As a species, brant have been shown to be highly sensitive to various disturbance stimuli throughout the annual cycle, including the wing molt period (Owens 1977, Miller 1994, Miller et al. 1994, Ward et al. 1994, Jensen 1990). For molting geese, several studies have documented substantial shifts in behavior, including spatial displacement, resulting from aircraft overflights (Mosbech and Glahder 1991, Jensen 1990). Little is known about response to other forms of disturbance stimuli during the goose molt period. To mitigate the potential negative effects of activities associated with the oil and gas development and production activities mentioned above, this alternative includes the following stipulations that help protect birds from disturbance by regulating the location of infrastructure: Stipulations E-2, E-11, K-1, K-3 (from both the Northeast and Northwest NPR-A plans), K-4, K-6, K-8 (Kasegaluk Lagoon Special Area), and K-11.

All alternatives allow summer tundra travel in NPR-A on a case-by-case basis only after extensive studies have been conducted (Required Operating Procedure/Best Management Practice L-1). Although travel off gravel pads is easiest in winter and generally environmentally preferable at that time, some vehicle travel off of pads does occur in North Slope oil fields during summer to accomplish specific tasks. The State of Alaska has approved some low-ground-pressure vehicles for summer tundra travel and similar summer tundra travel permit requests may be anticipated to be part of oil development in NPR-A. The need for visual inspection of oil and gas pipelines during the time that the tundra is not frozen is the situation that would most likely evoke a request for summer tundra travel. Summer tundra travel poses a high potential for disturbance of birds as great numbers of birds are present in the NPR-A during this time.

Activities that take place as a result of summer tundra travel could cause disturbances that may affect tundra-nesting birds. This disturbance could result in temporary or permanent displacement from preferred foraging, nesting, molting, staging, and brood-rearing habitats; decreased nest attendance; nest abandonment; nest destruction; nest predation; and increased energy expenditures that could affect survival or reproduction. The likelihood for impacts to tundra-nesting birds would vary, depending on the location of the summer tundra travel, the species and number of individuals in the area, and the period of travel in relation to the breeding chronology (birds are more sensitive to disturbance during some periods). Impacts would be most likely to occur if summer tundra travel occurred in habitats with high bird concentrations, in areas containing species that are vulnerable to small losses of nests and habitats that may be limiting for a particular species, and during the molt period in areas where large numbers of birds congregate to molt were disturbed during nesting or brood-rearing.

Aircraft, both fixed-wing and helicopter, would provide access for oil and gas-related activities throughout the development, operation, and abandonment of any oil or gas field developed in the NPR-A. This could include air support for ground surveys of wildlife, archaeological, hydrological, aerial surveys for other resources; road and pipeline route surveys; pipeline inspections; and support for many other development, operation, and abandonment activities. The location, timing, and frequency of such flights and the type of aircraft used will be influenced by the phase of oil and gas development and operation, the location of any oil or gas discovered, the type of development that might occur, as well as restrictions that the BLM and other regulators might place on the lessee or permittee (see the section “ Description of Typical North Slope Oil and Gas Activities” on page 7 for a discussion of potential number of flights associated with various activities). The potential for disturbance to waterfowl from aircraft is well documented (e.g., Schweinsburg 1974; Ward and Stehn 1989; Derksen et al. 1992; McKechnie and Gladwin 1993; Ward et al. 1999).

Johnson et al. (2003b) conducted a study of aircraft disturbance of waterfowl at the Alpine oil field and responses of birds to aircraft included alert postures, interruption of foraging behavior, and flight. Aircraft disturbances could displace birds from feeding habitats and negatively impact energy budgets. Gollop et al. (1974b) and Ward et al. (1999) suggested that helicopters may be more disturbing to wildlife than low-flying fixed-wing aircraft, although Balogh (1997) indicated that fixed-wing aircraft flown at 150 feet above ground level often caused spectacled eiders to flush, while helicopters flown at similar altitudes in the vicinity of Prudhoe Bay did not. In a simulation study, Miller (1994) suggested that altering helicopter routes through the goose molting area would likely reduce the impacts on molting brant substantially. Flights parallel to the coast may disturb brant up to 1 mile inland (Miller 1994). Other studies have reported little response by molting waterfowl to aircraft overflights (Gollop et al. 1974a). Under Alternative A, leasing would be deferred in the goose molting area until 2018. Permanent oil and gas facilities (with the exception of pipelines) would be prohibited on the lake buffers illustrated in Map 2-1 and 2-1T and most aircraft overflights in this area would likely be at altitudes sufficiently high to avoid disturbance to waterfowl (see Required Operating Procedure F-1). Aircraft disturbance would be likely to affect waterfowl and other bird groups in those portions of the NPR-A open to development, with the effects of aircraft disturbance likely being lowest in Alternatives B-1 and B-2, third lowest in Alternative A, with the most disturbance likely in Alternatives C and D.

The potential effects of routine aircraft flights into airstrips at oil and gas developments would range from bird avoidance of certain areas to abandonment of nesting attempts or lowered survival of young. The likelihood that noise associated with aircraft would have a negative impact on birds would probably be greatest during the nesting period when the movements of incubating birds are restricted and the molting period when, in addition to being a period of restricted movements, birds may be energetically stressed and are known to be sensitive to disturbance. The highest levels of aircraft noise would occur during takeoffs as engines reach maximum power levels. During landings, aircraft noise levels would be reduced as engine power decreased. In the NPR-A, aircraft activity would likely be greatest during the construction period, when more personnel and equipment would be transported to areas being developed than during the production period, when activity levels would be reduced (Johnson et al. 2003b).

The Alpine oil field avian monitoring program was a multi-year project designed to identify the potential effects of noise and disturbance from aircraft on birds nesting near the airstrip and on large waterbirds during brood-rearing (Johnson et al. 2003b). During years of heavy construction, white-fronted goose nest sites were apparently displaced to habitats similar to those used prior to construction, but located farther from the airstrip. Johnson et al. (2003) found that at the Alpine oil field, white-fronted geese at failed nests were more likely to take incubation recesses than geese at successful nests. A higher frequency and duration of recesses may allow for increased predation by jaegers, gulls, ravens, and foxes at unattended nests. The probability of taking a recess increased as noise level increased, when aircraft were present, when the number of vehicles decreased, and when pedestrians were present. Geese nesting less than 6,500 feet from the airstrip were more likely to take more frequent recesses than birds more than 6,500 feet from the airstrip.

Johnson et al. (2003b) also reported on tundra swans and yellow-billed loons nesting in proximity to the Alpine oil field airstrip. There was no difference among years in the mean distance of tundra swan nests relative to the airstrip, closest gravel source, or aircraft flight path. In 1998, a tundra swan nested successfully 520 feet northeast of the airstrip, despite daily helicopter activity near that end of the airstrip during late June and early July. Another pair of tundra swans nested successfully from at least 1997 through 2002 at a site approximately 1,470 feet southwest of the airstrip and 470 feet from the infield road. These nests were successful, despite their proximity to the airstrip and their locations under the takeoff and approach patterns of aircraft. Disturbance effects of the various components of the Alpine oil field apparently were not severe enough to cause major changes in tundra swan nest-site selection. Similarly, no evidence was found that the development affected the distribution and abundance of yellow-billed loon nests located near the airstrip, although the sample size was small. Johnson (1984) reported that at least three successful common eider nests were located within 975 feet of a helicopter pad on Thetis Island that averaged 12 trips per day. Although the potential exists for displacement of some nesting birds near routinely used aircraft landing sites as a result of numerous overflights, landings, and takeoffs, some birds may habituate to routine air traffic.

Derksen et al. (1992) reported that molting brant in the Teshekpuk Lake goose molting area were disturbed by helicopter overflights and that brant did not habituate to the overflights. Low-level helicopter survey flights to monitor the condition of the pipeline could disturb tundra-nesting or post-breeding birds. Routine flights would be of short duration and occur in a particular area, and would likely cause minimal disturbance to birds. However, temporary displacement from preferred habitats could affect energy budgets of some birds, and incubating birds could be temporarily displaced from nests. Under Alternative A, leasing would be deferred in the goose molting area until 2018.

Several types of watercraft could be used during the summer and fall for transporting equipment and supplies and for oil or gas spill response training drills. Summer and fall barge traffic would transport equipment and supplies to staging areas along the coast. For each oil or gas central processing facility that is developed, one to two sealifts (each with approximately 30 barges) would be required to transport the necessary supplies and equipment. Barges would be unloaded at staging areas along the coast and materials would be stockpiled there until being moved in winter over ice roads to the construction location. This barge traffic could displace molting and staging waterfowl and loons from preferred areas during the period mid-July through October. Displaced birds would probably move to adjacent habitats or return to their original habitats after the barges passed through the area. It is well known (Avery et al. 1980, Springer and Dailey 1980, Day et al. 2003) that birds may be attracted to sources of light with the potential for the bird to strike a structure (building, barge, tower, etc.) resulting in the possibility of mortality. There are documented accounts of waterfowl and seabirds being attracted to and colliding with ships (Dick and Donaldson 1978). Eiders in particular are thought to be susceptible to collision with human-made structures because they fly fast and low over the water while migrating, and are attracted to lights (Day at al. 2003 and references contained within). However, there is a short window of time during the fall when the region is dark and birds are present; thus, the potential for collisions between waterfowl and barges is low. Effects of barge traffic would vary in intensity, depending on the timing, location, and duration of the traffic in areas of high bird concentrations. The potential for the greatest frequency of disturbance to waterfowl from barge traffic would occur in Alternatives C and D, and would be lowest in Alternatives A, B-1, and B-2.

Oil spill response training activities using watercraft could be conducted on rivers and lakes several times during the open-water season. The vessels used would likely be small, maneuverable crafts suitable for shallow waters. They may include airboats and hovercrafts, which are types of watercraft for which the impacts on birds in the NPR-A are unknown. Spill response training activities would have the potential to disturb foraging, nesting, or brood-rearing waterfowl and other birds. Boat activity can cause alert postures, disruption of feeding behavior, and flight in waterfowl, shorebirds, and raptors (Burger 1986, Belanger and Bedard 1989, Steidl and Anthony 2000). Rodgers and Smith (1995) and Rodgers and Schwikert (2001) determined set-back distances for minimizing the potential for boat disturbance to various bird groups these suggested buffer zones around areas of activity ranged from 325 feet for shorebirds to 600 feet for wading birds.

Predation

Predators such as ravens, gulls, arctic fox, and bears may be attracted to areas of human activity where anthropogenic sources of food and shelter are present (Eberhardt et al. 1982, 1983a, b; Day 1998; Burgess 2000). The availability of anthropogenic food sources, particularly during the winter, could increase survival of these predators and contribute to increases in their population. Increased levels of predation due to elevated numbers of predators could, in turn, impact bird populations. Major negative impacts have occurred at the Howe Island goose colony in the Sagavanirktok Delta from predation by arctic fox and grizzly bear (Johnson 2000a), and Arctic foxes and glaucous gulls are predators of common eider and brant eggs and young on the barrier islands (Noel et al. 2002). In 2009, grizzly bear predation on nesting snow geese at the Ikpikpuk River Colony in NPR-A caused nearly complete nest failure; only 1 percent of 2,638 nests of known fate were successful (Ritchie et al. 2010). Arctic fox predation can also impact tundra-nesting shorebirds and passerines (Day 1998, Rodrigues 2002). Liebezeit et al. (2009) conducted a study at sites across the Arctic Coastal Plain, which compared the nest survivorship of shorebirds and passerines relative to the distance from oilfield infrastructure. Results from that study indicated that passerine populations are at greater risk of predation within 5 km of infrastructure although no effect was detected on nest survival of shorebirds, as a group, associated with distance from infrastructure. Liebezeit et al. (2009) also conducted a posteriori finer-scale analyses (within oil field sites and individual species) which suggested that Red and Red-necked Phalaropes combined had lower productivity closer to infrastructure and in areas with higher abundance of subsidized predators. However, that relationship between infrastructure and nest survival for semipalmated and pectoral sandpipers, the two most abundant shorebirds in the study, was not found.

In recent years, oil field operators have installed predator-proof dumpsters at camps and implemented new refuse handling techniques to minimize the attraction of predators to the landfill. In addition, oil field workers undergo training to make them aware of the problems associated with feeding wildlife. At the Alpine oil field, Johnson et al. (2003b) reported that except for one pair of nesting ravens, the numbers of predators and levels of predation after development did not increase in the area compared to pre-development levels. In all alternatives, Required Operating Procedure/Best Management Practice A-2 requires proper disposal of refuse to avoid human-caused changes in predator populations while E-9 requires that structures do not create denning or shelter sites for predators.

There have been some indications that researchers conducting studies on avian nest density and success may inadvertently affect the results by attracting predators to nests and broods (Bart 1977, Strang 1980, Johnson 1984, Götmark 1992). Birds that are flushed from their nests during surveys may be more susceptible to nest predation than undisturbed birds. However, Vacca and Handel (1988) reported that covering eggs with down after incubating geese were flushed from nests essentially negated the effect of attracting predators during nest visits. Nonetheless, ongoing activities with repeated disturbance by researchers could cause some mortality to eggs and chicks of tundra-nesting birds.

Abandonment and Reclamation

Oil and gas field abandonment scenarios include both active and passive reclamation strategies. Gravel pads and roads may be purposefully removed or left in place indefinitely. Revegetation could occur through intentional seeding with native vegetation or through natural colonization. Given this uncertainty, it is very difficult to determine potential effects to birds from these unknown activities. For this document, it is assumed that all gravel will be removed after abandonment. Given that assumption, the impacts of abandonment and reclamation of oil and gas fields on birds would be similar in many respects to those incurred by construction activity.

Activities occurring in the winter would cause little disturbance or displacement, because most species would be absent from the area. Summer road and air traffic generated by abandonment and reclamation activities could cause disturbance, displacement, and mortality to birds that would be similar to, and at the same levels as that caused by traffic during construction and operations.

If pads, roads, and airstrips are not revegetated, their value to birds would be lessened. If they were revegetated without removing the gravel, the habitat would not return to its current utility for most birds. If gravel was removed, habitat similar to that currently existing in the area could be created and used by birds, although the precise mix of habitat types would likely not be the same as what prevailed at the time of disturbance. Foam insulating materials used in pad construction could be broken up in the course of removal. Fine particles of foam not removed from the environment could be ingested by some birds incidentally; depending on the material's toxicity and the amount ingested, ingestion of foam could cause sickness or mortality, though the number of individual birds harmed would likely be very small. Stipulation G-1 requires that upon abandonment or expiration of leases, all oil and gas facilities will be removed unless the authorized officer determines that it is in the best interest of the public to retain a structure. When determining if a structure should be retained, consideration will be given to what the impacts of retention will be on molting geese and goose molting habitat.

Oil Spills and Gas Releases

Crude oil spills could occur from pipelines, storage tanks, production and exploration facilities, drilling rigs (well-control incidents), and vessels. Spills that leave the pads and roadbeds, or enter water sources directly, could reach one or more of several habitat types, including wet and dry tundra, ponds, lakes, flowing creeks and rivers, and potentially the adjacent nearshore waters of the Beaufort or Chukchi seas. Spills could occur any time during the year. Onshore or offshore refined-oil spills could occur along ice roads, or from barges, helicopters, airplanes, gravel pad facilities, or trucks along the road system. Typical refined products spilled on the Alaska North Slope are aviation fuel, diesel fuel, engine lube, fuel oil, gasoline, grease, hydraulic oil, transformer oil, and transmission oil. Refined oil is most often spilled in very small volumes and is addressed here in conjunction with crude oil in small spill scenarios to address concerns about the potential chronic effects from numerous small spills. Seawater or produced or process water, used for enhancing oil production, could be spilled within the planning area affecting tundra or freshwater habitats. The gas produced in NPR-A is expected to be dry gas (no water or condensates). These releases would be localized to the area adjacent the release site.

There is potential for negative impacts to birds from oil spills of all sizes and types occurring on land or on water (lakes, streams, rivers, marine waters). Spills of crude oil and refined products onto tundra, freshwater, or marine environments could affect birds through any and likely a complex interaction of the following: direct oiling of plumage, oiling of eggs, ingestion of oil, contamination of food resources, disturbance due to cleanup efforts, and long- and short-term loss or alteration of habitat due to spilled oil and cleanup activities. The extent of impacts to birds would depend upon the type and amount of materials spilled, location of the spill and types of habitats impacted, spill rate, time of year, weather conditions, and the effectiveness of the response.

Low tundra relief and topographical features in the NPR-A would limit the spread of oil. During the summer, coastal tundra has the ability to absorb large quantities of oil, also limiting the spread of the spill. In winter, when the ground and water surfaces are frozen, spreading of oil is controlled by the snow cover or frozen soil. Snow cover can act as an absorbent, slowing the spread of oil or preventing the spill from reaching the tundra surface. Oil tends to spread on the surface of the frozen soil, and penetration of oil into the soil is limited. However, if a spill event includes aerial, pressurized discharge, then even small spills can be spread over large areas. With the high-velocity, bi-directional winds on the North Slope, oil can be misted miles downwind of a leak. If a spill occurred during spring break-up, river water flooding over land combined with ice and snow damming could spread oil over a large area of tundra. Oil spills or leaks onto tundra could negatively impact birds in numerous ways. Oil could come in contact with and adhere to feathers, causing them to lose their insulating capabilities and result in hypothermia (Patten et al. 1991). This effect would be particularly severe for birds that come in contact with water where feather integrity is necessary to maintain water repellency and buoyancy. Birds could also suffer toxic effects from ingestion of oil by consumption of food contaminated by an oil spill or from oil ingestion resulting from preening of oiled feathers (Hansen 1981). Oil contacting eggs directly as a result of a spill, or indirectly from oiled feathers of incubating adults can cause toxic effects to embryos (Patten and Patten 1979, Stickel and Dieter 1979).

Oil spilled on land could also enter a lake or pond and be contained by the banks of these waterbodies. Because of the increased viscosity of oil in cold water, oil spreading on the water surface would be restricted in most waters within the planning area. Oil spilled into moving water (rivers or streams) would be subjected to the dynamics of the moving water environment where the spreading of the oil would be mandated by the surface currents and other forces within the moving water, making estimates of movement rates, duration of threat, and effective treatments difficult.

Effects to birds (primarily waterfowl, loons, and shorebirds) from oil spilled into freshwater could be more severe, depending on the time of year, than those of a spill on tundra. During spring and fall, many species use rivers, streams, and lakes as transportation corridors and gathering places. An oil spill occurring during these periods would have the potential to negatively affect large numbers of birds. During the fall, large numbers of juvenile birds of many species congregate along waterways, and a spill during this time has the potential to significantly negatively affect the year's productivity of many individuals. The potential for an oil spill to enter major rivers or streams would be minimized by a number of required operating procedures and stipulations. In all alternatives, Required Operating Procedure/Best Management Practice A-5 prohibits refueling of equipment within 500 feet of an active flood plain, and Stipulation E-2 prohibits permanent oil and gas facilities including roads, airstrips, and pipelines within 500 feet of fish-bearing waterbodies. All alternatives also contain Stipulations K-1 and K-2, which protect rivers and lakes, respectively, by prohibiting most permanent oil and gas facilities within specified distances from specific rivers (variable by alternative) and from within a quarter mile of any deep water lakes. In Alternative A, Stipulation K-4 protects waters within the goose molting area by prohibiting permanent oil and gas facilities including roads and airstrips, but not pipelines, from the buffer zones established for the area. However, if oil were spilled during the winter and not completely cleaned up or spilled during the spring break-up, surface flow of water could carry oil to streams and rivers.

Oil spilled from a barge or support vessel, or transported into marine habitats, would have the potential to spread oil over a larger area than in terrestrial habitats due to winds and currents. Therefore, birds found in marine habitats within NPR-A could be particularly susceptible to the negative impacts of an oil spill. An oil spill spreading into offshore waters of the planning area could affect molting, brood-rearing and staging waterfowl, including red-throated loons, long-tailed ducks, scoters, and king and common eiders (Fischer et al. 2002). An oil spill in coastal zone habitats of the Colville River Delta, Harrison Bay, Smith Bay, Dease Inlet, Elson Lagoon, Peard Bay, Kuk River, or Kasegaluk Lagoon, which support large congregations of post-breeding shorebirds and waterfowl, could affect large numbers of birds. Cleanup during periods when broken ice is present would be difficult, and oil may linger well into the spring/summer sea ice melt period. Oil present during spring would be hazardous to migrating and staging birds. Lingering effects from a winter marine spill could impact birds returning during the following breeding season, if cleanup activities did not adequately remove contaminants from bird habitats and food sources. In addition, oiled carcasses of dead birds washing up on beaches or shorelines could be hazardous to scavenging birds such as gulls and golden eagle.

Oil-spill-response activities would disturb birds if they were present in the response area. The extent of the disturbance would depend upon a variety of factors, including spill size and location, response actions, weather, and season. Aircraft, pedestrians, watercraft, or overland vehicles could temporarily disturb birds in similar ways to those discussed previously. Response to disturbance could last from a few minutes to multiple days. Displacement of birds could occur on a temporal scale of a few days to the duration of the period that animals would normally be present in the spill area in a given year. Depending on the location, size, and timing of the spill, birds may be affected by loss of life, reduced survival, reduced future breeding opportunities, loss of yearly nesting attempt, loss of brood or loss of body condition. McDonald et al. (2002) developed a hypothetical spill scenario involving terrestrial and aquatic spills in the Prudhoe Bay area that covered 24 and 186 acres, respectively. Assuming a nest density of 0.6 nests per acre on 145 acres of tundra covered by a terrestrial oil spill, approximately 87 nests would be affected by the spill (McDonald et al. 2002). In most cases, onshore oil spills would not be expected to affect birds directly through ingestion of oiled vegetation. For large spills that are not immediately or successfully cleaned up, the potential for contamination would persist for at least five years (see section 4.2.2.1 “Fate and Behavior of Spilled Oil” on page 85), and there would be a greater likelihood of birds being exposed to the oil through ingestion of contaminated prey items. Cleanup success would likely vary depending upon the environment (see section 4.3.5 regarding effects of oil on different types of vegetation). Terrestrial habitat would be lost for use by birds during the spill, clean-up and some period after the cleanup while vegetation recovery is occurring. Over time, any remaining oil would gradually degrade. Although oiling of animals would be unlikely to remain a threat after cleanup efforts, some toxic products could remain for some time. Depending upon the spill environment, a portion of the oil could persist for at least five years (see section 4.2.2.1 “Fate and Behavior of Spilled Oil” on page 85).

The assumed volume of small crude and refined oil spills over the life of the development in NPR-A under Alternative A is estimated to be 717 barrels. This estimate is quite close to the estimates for Alternatives C and D (702 and 755 barrels, respectively). The estimate for Alternative B-1 is 500 barrels, and B-2 is 546 barrels. Because of the relatively small volumes involved and the substantial emphasis on oil-spill prevention and response measures, small spills associated with Alternative A would not likely have a measurable effect on birds at a population level in the NPR-A, although effects to individual birds could range from short-term disturbance to death. Many factors would determine the probability that birds would be negatively impacted by a small oil spill, including the quantity spilled, season, location (e.g., land versus water), and proximity to sensitive habitat. Potential for impacts to birds from small crude or refined oil spills under Alternative A would be slightly lower, as compared to Alternatives C and D, but greater than under Alternatives B-1 and B-2.

The assumed volume of a large crude oil spill over the life of the development in NPR-A under all alternatives is estimated to be 5,100 barrels from an estimated one large crude spill. Although the estimated large spill volume is the same for all alternatives, the probability of a spill occurring varies between Alternatives A, C, and D (37, 37, and 39 percent, respectively) and Alternatives B-1 and B-2 (28 and 30 percent, respectively). Even with the protection of particularly sensitive areas (coastal shoreline, goose molting area), and the substantial emphasis on spill prevention and response, a large crude oil spill associated with Alternative A, if it occurred, could have a measurable effect on birds at a population level in the NPR-A, and the effects to individual birds could range from short-term disturbance to death. Impacts to birds on a population level could occur if oil from a large spill entered rivers, important molting or brood-rearing lakes, or marine areas during periods when large proportions of specific populations (e.g., brant, long-tailed ducks, eiders, and shorebirds) were present. Many factors would determine the probability that birds would be negatively impacted by a large oil spill, including the quantity spilled, season, location (e.g., land versus water), and proximity to sensitive habitat. Although the probability of a spill varies by alternative, the impacts to individual birds from large crude or refined oil spills would be the same as under all alternatives if a spill were to occur in a location where birds were present.

If seawater were used for enhancing oil production, a saltwater spill could occur within the NPR-A. Spills of seawater and produced water are soluble and mobile in non-frozen soils. Flushing with water can return surface soil salinity to near-normal conditions within 30 days in wet tundra, but salt may persist longer at moist or dry sites (Simmons et al. 1983). According to McKendrick (2000), brine spills kill plants on contact and increase soil salinity to the point that many species cannot survive. Unlike oil, salts are not biodegradable, and natural recovery occurs only after salts have leached from the soil. A spill would have effects on salt-intolerant vegetation near the seawater spill, but the amount of tundra habitat affected would likely be no more than a few acres. Thus, unless a seawater spill occurred in high-density foraging habitat, forage availability for birds would not likely be affected. Over the long term, mortality of vegetation in the area affected by the spill would make the area undesirable for grazing by birds until the vegetation recovered.

The assumed volume of a large (500 barrels or more) produced water or seawater spill for the development life of the NPR-A under all alternatives is estimated to be 1,900 barrels from one spill. Although the estimated spill volume is the same for all alternatives, the probability of a spill actually occurring varies between Alternatives A, C, and D (55, 54, and 57 percent, respectively) and Alternatives B-1 and B-2 (43 and 44 percent, respectively). Many factors will determine the probability and extent to which birds will be negatively impacted by a seawater spill, including the season and proximity to sensitive habitat. The probability of impacts to birds from a seawater spill under Alternative A would be about the same under Alternatives C and D, but greater than under Alternatives B-1 and B-2.

There are three potential ways that gas releases could occur in the NPR-A, from: (1) loss of well control at production areas, (2) ruptured gas pipelines, and (3) leaks at gas processing facilities. Gas releases could occur at any time of the year, and these releases would be localized to the release site. It is estimated that there would be one gas release incident during the life of gas development in NPR-A. Methane (primary component of natural gas) is lighter than air and tends to rise and dissipate into the atmosphere. The main hazard associated with natural gas is its flammability. If an ignition source exists, a gas release can result in an immediate fire or explosion near the point of the release; thermal effects could reach within 500 meters of the explosion. Due to the localized nature and short duration of a gas release, effects to birds would likely be much less severe than those of an oil spill. A small number of individual birds could be injured or killed by an explosion; however, a population-level response would not be expected.

Human response activities to a gas release would disturb birds if they were present in or near the release area. The extent of the disturbance would depend upon a variety of factors, including release size, duration and location, human response actions, weather, and season. Aircraft, pedestrians, watercraft, or overland vehicles would temporarily disturb birds present in the vicinity of the release. Response to disturbance could last from a few minutes to a few hours to multiple days. Displacement of birds could occur on a temporal scale of a few days to the duration of the period that animals would normally be present in the release area in a given year. Depending on the location, size, and timing of the release, birds may be affected by loss of life, reduced survival, reduced future breeding opportunities, loss of yearly nesting attempt, loss of brood or loss of body condition. Any emergency pipeline repair occurring in summer would have the potential to disturb birds and their habitats.

A gas release from a well is expected to last one day, and release 10 thousand cubic feet of gas. A transmission pipeline or processing facility is estimated to release 20 thousand cubic feet over a few hours. Although the estimated release volume is the same for all alternatives, the difference in the estimated number of gas production pads and lengths of various pipelines would change the probability of a release among the alternatives. Impacts to birds from a gas release under Alternative A would be less than under Alternatives C and D, but greater than under Alternatives B-1 and B-2.

4.3.8.3 Effectiveness of Stipulations and Required Operating Procedures

Numerous stipulations and required operating procedures in Alternative A were developed to effectively protect birds and their habitats within the NPR-A. These include Required Operating Procedures A-1 through A-7 and E-9, which ensure that solid, liquid, and hazardous wastes (including fuels) do not impact birds or their habitats, and to reduce the potential for garbage and shelters that attract predators. The protection of bird habitats and food sources are addressed by Required Operating Procedures B-1, C-3, C-4, and

Stipulations E-2 and L-1, among others. The K series of stipulations provide additional protections in biologically sensitive areas, and many of these provide protections to bird habitats and food sources, although Stipulations K-3b and K-6 excludes Kasegaluk Lagoon and Peard Bay in Alternative A. In the Colville River Special area, Required Operating Procedures E-15, E-16, and F-1, and Stipulation K-7 provide protections to raptors by preventing habitat loss, minimizing disturbance (air and ground) and preventing loss of birds by electrocution. The stipulations and required operating procedures listed above apply to all alternatives, although in Alternatives B-1, B-2, C, and D, the required operating procedures are renamed best management practices. In the Kasegaluk Lagoon Special Area there are protections in place to protect birds through a deferral of leasing until 2014, and after that deferral is lifted, there is a prohibition on locating oil and gas facilities within the boundaries of the Special Area (Stipulation K-8). The Teshekpuk Lake Special Area and the goose molting area within the Teshekpuk Lake Special Area provide numerous protections to birds and bird habitat. Much of the Teshekpuk Lake Special Area north and east of the lake is deferred from leasing until 2018, and the goose molting area is further protected by Stipulations K-4 and K-11, which prohibit permanent oil and gas facilities (with the exception of pipelines) near goose molting lakes and, among other things, restricts the total area that can be developed. In addition, there are numerous required operating procedures and stipulations that regulate the types of activities that can occur near waterbodies, including rivers and streams, types of equipment that can be used in the planning area, will serve to protect birds and their habitats. Finally, Alternative A provides stipulations and required operating procedures that provide protection that is superior to that provided by Alternative D, but provides fewer protections than those contained in Alternatives B-1, B-2, and C. As there has been no oil or gas development yet in the NPR-A, it is difficult to determine the effectiveness of the above mentioned required operating procedures and stipulations. Required operating procedures and stipulations that have been in effect to date regulate exploratory activities, and thus far, seem to be effective in protecting birds and bird habitats.

4.3.8.4 Conclusion

Birds that could be affected by activities in the NPR-A include loons, waterfowl, shorebirds, raptors, passerines, seabirds, and ptarmigan. Most species in these groups migrate to wintering areas located outside of the NPR-A, and would not be directly affected by winter exploration or construction activities, although their habitats could be affected. A few species, such as ptarmigan, gyrfalcon, and snowy owl, may remain in the NPR-A during the winter, and could be temporarily displaced from preferred feeding or resting habitats by winter exploration or construction activities. Stipulations and required operating procedures regulating exploration activities are considered effective at protecting birds and bird habitats.

Non-oil and gas activities that could potentially affect birds include permitted recreation, guided hunting, activities associated with scientific surveys and research camps, cleanup of oil and gas exploration sites, and activities associated with government actions (e.g., cleanup of abandoned well sites). These activities could affect tundra-nesting birds by causing: (1) habitat loss, (2) disturbance or displacement, (3) increased predation, and (4) direct mortality. Impacts from these activities would most often be localized and on the scale of individual birds.

Activities related to oil exploration, development, and production, such as vehicle, aircraft, pedestrian and boat traffic, summer tundra travel, routine maintenance activities, heavy equipment use, facility noise, and oil spill cleanup activities, could cause disturbances that would affect birds. Most vehicle disturbance would likely be confined to areas within 160 to 685 feet of roads and pads. Disturbance related to aircraft activity would likely be confined to areas within 2,300 feet of landing strips, and little disturbance would be likely beyond 6,500 feet. Pedestrian traffic would likely cause more disturbance than other activities, as birds are less likely to acclimate to foot traffic than to routine aircraft or vehicular activity and to equipment or facility noise. Summer fixed-wing or helicopter aircraft activity in support of oil and gas exploration, including related research, could result in disturbance to birds, causing temporary or permanent displacement from preferred feeding, nesting, staging, or brood-rearing habitats in localized areas near areas of activity. Barges and other vessels could temporarily displace loons and waterfowl from preferred offshore and near-shore feeding, staging, brood-rearing, or molting areas. However, birds would likely move back to preferred areas after vessels passed through the area or continue to use adjacent areas, and the effects of occasional vessel traffic would likely be minimal. Effects may increase if vessel traffic becomes more than occasional. Smaller watercraft on rivers or lakes used during oil spill cleanup or training exercises also cause disturbance to birds. Surveys conducted prior to development would help identify areas with low levels of bird use that would be suitable for oil-spill-training activities and have the least impact.

Permanent habitat loss would result from gravel placement for roads and pads, and at gravel mine sites. Temporary habitat loss or alteration could also occur in areas adjacent to gravel roads due to snow and/or dust deposition, thermokarst, and the formation of impoundments. Some types of habitat alteration, such as the formation of impoundments, could be beneficial to some species, while having a negative impact on others. Withdrawal of water from source lakes during winter could impact birds if water levels or prey availability in source lakes were affected. Lake surveys conducted prior to water withdrawal, State of Alaska regulations, limits on the amount of water that may be withdrawn from lakes due to stipulations in Alternative A, and the ability of lakes to naturally recharge, would likely negate any potential negative impacts related to water withdrawal.

Bird mortality could result from collisions with ground or air vehicle or vessel traffic, or with towers, buildings, pipelines, power lines suspended from pipelines, bridges, or other facilities. It is expected that collisions would only be a minor source of bird mortality; however, over the course of the life of an oil or gas development these mortalities may accumulate for some species. Predators attracted to areas of human activity could also impact tundra-nesting birds by causing depredation of eggs and young; however, stipulations designed to eliminate attraction of predators to camps or equipment maintenance sites would help mitigate potential increases in predators. Adherence to stipulations that require proper disposal of garbage to avoid human-caused changes in predator populations would likely minimize potential impacts to birds from increased predation pressure. Additional bird mortality could result from subsistence hunting activities if oil field infrastructure were to provide hunters with access to previously inaccessible areas. Typically, however, subsistence users tend to hunt and fish away from oil and gas infrastructure (see section 4.3.13.3).

An oil spill or gas release could impact birds using terrestrial or marine habitats, and could have an effect on congregations of shorebirds and waterfowl. Potential impacts to birds would depend on the location and size of the spill and on the time of year. Due to the actions of wind and currents, a spill into the water would have a greater potential to spread to a large area than a terrestrial spill. A marine spill could impact thousands of molting and brood-rearing waterfowl and loons. A spill that impacted marine shorelines where shorebirds were staging would have the potential to impact large numbers of birds.

In general, impacts to birds from non-oil and gas activities, and from oil and gas exploration and development activities, would be additive. Potential impacts from seismic activity would vary by alternative, with Alternatives A, B-1, and B-2 each expecting to require five exploratory and six developmental seismic surveys (Alternatives B-1 and B-2 are expected to require greater area coverage by seismic survey than does Alternative A, so the total area impacted in Alternatives B-1 and B-2 will be larger than that in Alternative A; see Table 4-11). Alternatives C and D are estimated to require 14 and 16 total seismic surveys, respectively, which will cover a greater area than would be needed in Alternatives A, B-1 or B-2. The expected number of oil and gas fields and the level of development under Alternative A would be lower than under Alternatives C and D, but greater than under Alternatives B-1 and B-2. The probability of lands containing high-value bird habitat being developed is highest in Alternative D, lowest in Alternatives A, B-1, and B-2, and moderate in Alternative C. Therefore, it is expected that the potential effects of disturbance, habitat loss and alteration, and bird mortality due to oil and gas exploration and development under Alternative A would be greater than under Alternatives B-1 and B-2, but lower than under Alternatives C and D. The sum of effects from all activities authorized under this alternative, barring a large oil spill, is unknown but would likely produce no significant measureable effects on migratory bird populations. All alternatives would minimize unintentional take of migratory birds and conserve migratory bird populations.

Although many of the forces driving global climate regime shifts may originate outside the Arctic, the impacts of global climate change are exacerbated in the Arctic (Arctic Climate Impact Association 2004). Temperatures in the Arctic have risen faster than in other areas of the world, as evidenced by glacial retreat and melting sea ice. Given that, bird species whose range in Alaska is concentrated in the Arctic may be most vulnerable to the effects of a changing climate. These species include snow goose, king eider, red phalarope, stilt sandpiper, ruddy turnstone, pomarine jaeger, snowy owl, and Smith's longspur, among others. Effects to birds from climate warming may include a suite of effects, both positive and negative. A longer open-water season may increase productivity of some species of shorebirds and increase productivity in aquatic and semi-aquatic systems, which provide food for many species of birds. Melting sea ice may affect a few bird species, such as black guillemot that feed near the ice edge and may not be able to bring high-quality food to their young as the pack ice moves farther offshore.

Warmer soil temperatures are likely to increase thermokarst, and increases in sea level may inundate low-lying tundra areas, increasing salt marsh, aquatic, and wet tundra vegetation types, and erosion of coastal bluffs (Arctic Climate Impact Association 2004), and causing changes in coastal habitats that may quickly result in changes in vegetation that influence habitat suitability and availability for birds (Mars and Houseknecht 2007). The increasing thickness of the active layer of soil above Arctic permafrost is likely to cause changes in moisture regimes and the distribution of vegetation types over much of the

Arctic in coming years. Drying of wetlands would result in negative effects to those species that relay on shallow water and wet meadows, and shrub expansion may reduce the quality and availability of some types of habitats. Such impacts could accelerate or exacerbate changes in soil thermal regimes that occur with development, potentially leading to greater impacts to bird habitat.

High rates of coastal erosion and storm surges have led to saltwater intrusion into freshwater habitats, and such intrusions are expected to have altered goose foraging habitats, and may be the cause of the observed spatial redistribution of geese in the Teshekpuk Lake Special Area (USGS 2006). Increases in human economic activities such as shipping and offshore oil and gas development may influence the abundance and distribution of predators, which may negatively affect bird populations. These changes may be beneficial to some species such as those associated with boreal forest or shrub habitats, but a reduction in the amount of tundra habitat available could negatively impact tundra-nesting shorebirds and waterfowl and add to the cumulative effects of oil and gas development.

4.3.9 Terrestrial Mammals

Terrestrial mammals that could be affected under Alternative A include species such as caribou from the Teshekpuk Caribou Herd, Central Arctic Herd, and Western Arctic Herd; muskoxen; moose; grizzly bear; wolf; wolverine; arctic fox; and red fox. Dall sheep would not be affected by activities associated with oil and gas exploration or development under Alternative A because there would be neither in the southern portion of the NPR-A where Dall sheep may be found. They may be affected only by activities not associated with oil and gas exploration and development such as aircraft, camps, research, and recreation.

The following analysis for Alternative A summarizes the information previously presented in the 1998 Northeast IAP/EIS (USDOI BLM and Minerals Management Service 1998), which has been amended with additional data from studies conducted since 1998, particularly for the Northwest IAP/EIS (USDOI BLM and Minerals Management Service 2003) and the Northeast Supplemental IAP/EIS (USDOI BLM 2008), and broadens the context to include the entire National Petroleum Reserve-Alaska (NPR-A). It has also been updated with a new scenario for "reasonably foreseeable development" of oil and gas resources.

4.3.9.1 Activities Not Associated with Oil and Gas Exploration and Development

Activities such as resources inventories, aerial surveys, research camps and permitted recreation would have short-term effects on terrestrial mammals.

Effects of Disturbances

Non-oil and gas activities that could disturb terrestrial mammals include aerial surveys and ground activities such as resource inventories, paleontological excavations, research camps, (including those conducting environmental studies for potential future off-shore oil/gas developments), recreational camps, and overland moves. Some wildlife surveys would occur during spring. Overland moves would occur during the winter on frozen tundra, ice roads, or stable shore-fast ice. Other activities would occur from summer to early autumn (June through September). Potential causes of disturbance to terrestrial mammals from inventory or research activities and overland moves would be helicopter traffic, fixed-wing aircraft traffic (see "Logistics" in section 4.2.1.2), vehicular traffic on ice or snow roads, and humans on foot. Caribou have been shown to exhibit panic or violent, running reactions to aircraft flying at elevations of approximately 160 feet and to exhibit strong escape responses (animals trotting or running) to aircraft flying at 150 to 1,000 feet (Calef et al. 1976). These documented reactions were responses to aircraft that circled and repeatedly flew over caribou groups. While aircraft associated with aerial wildlife surveys might circle or fly over a group of caribou more than once, aircraft associated with support of survey and inventory camps would pass over caribou only once on any given flight to or from a camp. Recreational and research camps could result in short-term displacement (24 hours to several weeks) or harassment of terrestrial mammals and minor disturbance to forage plants due to trampling. Potential habitat disturbance from large camps could be reduced by using existing sites whenever possible, as practiced by BLM field personnel and permittees doing research for multiple years.

In some cases, recreational camps could attract grizzly bears and arctic and red foxes, resulting in defensive shooting of bears that learn to associate humans with food sources, or the shooting of foxes that present a risk to personnel safety because of rabies. Any such losses would be minor or negligible to the bear or fox populations on the North Slope, but would contribute to cumulative effects.

Effects of Spills

Very small fuel spills (probably less than 1 barrel) could occur in association with resource-inventory surveys, recreational activities, and overland moves. These spills would likely involve aviation fuel and other light-fraction hydrocarbon fuels that would evaporate and disperse rapidly in the environment with only a local effect on vegetation. Under current BLM regulations, fuel spills would be cleaned up immediately, if possible. However, it is not clear how many spills go unreported. Small spills associated with non-oil and gas activities would not be expected to have a substantial effect on terrestrial mammal populations in the NPR-A, although they could greatly affect individual animals that ingest the fuels through contaminated water or plants.

4.3.9.2 Oil and Gas Exploration and Development Activities

Under Alternative A, approximately 57 percent (13 million acres) of the NPR-A's approximately 22.8 million subsurface acres would be available for leasing and possible development, with no leasing throughout the southwest portion of the NPR-A. The exploration scenario under Alternative A assumes that one 2-D and ten 3-D seismic surveys would be conducted over the next 30 years. It also assumes that 196 oil or gas exploratory or delineation wells would be drilled from winter ice pads over that period. The development scenario under Alternative A assumes that 12 central processing facilities for oil and 27 central processing facilities/gas compressor facilities for gas along with associated production pads and other facilities would be developed in the NPR-A. Impacts to terrestrial mammals are expected to come from motor vehicle, foot, and aircraft traffic, seismic operations, oil spills, gravel mining, and construction. The primary impacts to terrestrial mammals would likely be those associated with disturbance and habitat alteration, and potentially could include increased energy expenditure, decreased body reserves and reduced reproduction and calf survival (productivity).

Effects of Disturbances

Seismic Activities

Impacts to habitat used by terrestrial mammals would be minor, as most seismic activities would occur during the winter on frozen tundra or ice. Potential causes of disturbance to terrestrial mammals from seismic activities would include surface vehicular traffic on frozen tundra or ice and fixed-wing aircraft traffic. In most cases, these activities would cause short-term displacements of and/or disturbance to terrestrial mammals. Where 3-D seismic exploration survey lines are located only 660 to 1,200 feet apart, localized displacement of terrestrial mammals could last for several days or lead to complete abandonment of localized habitat.

Effects on caribou and moose would be similar to those discussed under non-oil and gas activities, but would likely be greater in extent, frequency, and duration. During winter, moose move to the riparian areas of large rivers; in the NPR-A, they are most likely to concentrate along the Colville River. The Teshekpuk Caribou Herd caribou are present throughout much of the NPR-A during the winter, with large numbers often congregating in the central and eastern portions of the NPR-A. Therefore, caribou would likely be encountered during seismic surveys in the NPR-A. It is possible that displacement of caribou by seismic exploration activities during winter could have a negative effect on their energy balance (intake versus expenditure). Because these animals are mobile and the operation would be short in duration (e.g., 2 to 3 days in one area), it is not anticipated that any lasting adverse impacts to caribou would result under most circumstances. However, this assumption has not been scientifically tested and conditions for winter survival vary from year to year. It is possible that this disturbance could have an additive effect on natural winter mortality and could disproportionately impact young of the year and pregnant cows.

Previous studies of the effects of oil and gas exploration on muskoxen in Alaska and Canada focused on disturbances associated with winter seismic operations. Some muskoxen reacted to seismic activities at distances up to 2.5 miles from the operations; however, reactions were highly variable among individuals (Reynolds and LaPlant 1985). Responses varied from no change in behavior to becoming alert, forming defense formations, or running away (Winters and Shideler 1990). The movements of muskoxen away from the seismic operations did not exceed 3 miles and had no apparent effect on muskox distribution (Reynolds and LaPlant 1986). Unlike caribou, muskoxen are not able to travel and dig through snow easily. In the winter, they search out sites with shallow snow, and greatly reduce movements and activity to conserve energy (USDOI U.S. Fish and Wildlife Service 1999). Muskoxen survive the winter by using stored body fat and reducing movement to compensate for low forage intake (Dau 2001). Because of this strategy, muskoxen may be even more susceptible to disturbances during the winter. It is possible that repeated disturbances of the same animals during winter could result in increased energetic costs that could increase mortality rates. Depending upon the location of the seismic exploration, impacts on muskox populations would be non-existent to minor. Mixed-sex groups of muskoxen have recently been observed in the NPR-A, in the upper Colville River area and the vicinity of Teshekpuk Lake (section

3.3.6.2 in Volume 1). However, potential habitat occurs throughout, and populations outside of the NPR-A are gradually expanding their range.

Exploration activities and human presence pose potentially serious disturbances to hibernating bears, particularly maternal females with cubs. In one study, seismic activities within 0.9 to 1.1 miles of a grizzly bear den caused changes in heart rate and movement of the female bear and cubs (Reynolds et al. 1986). However, this seismic testing involved the detonation of dynamite, a technique that would not be used under the scenario provided here. Also, none of the bears in that study left their dens. The investigators suggested that seismic testing activities within about 600 feet of a den may cause den abandonment. Under Alternative A, Required Operating Procedure C-1 prohibits exploration activities within a half mile of occupied grizzly bear dens. If den locations were known in the areas in which seismic work is planned, impacts to hibernating bears would be reduced. Overall, it is expected that impacts to bears would be negligible to minor, since the level of proposed seismic work is low (11 surveys over 30 years). In addition, the area of highest potential for oil is the lowest density grizzly bear habitat. Conversely, the highest grizzly bear density is located in the extreme southern portion of the NPR-A, where no economic oil or gas is assumed to occur.

Seismic camps could result in localized disturbance and/or displacement of terrestrial mammals for up to a few days. Bears and foxes could also be attracted to camps, and in rare instances, conflict could result. Since seismic camps generally move at least once a week and proper handling of wastes would be regulated by lease stipulations, the potential for bears or foxes to be attracted to human food sources would be minor. In addition, most seismic activity would occur when bears were hibernating and not attracted to scents.

The potential effects of seismic activities on wolverines would include disturbance from air and surface vehicle traffic, and increased human presence. Wolverines are considered a shy and secretive species that is present at very low densities and may be sensitive to disturbance. Winter seismic activities in the Pik Dunes area south of Teshekpuk Lake are reported to have caused the displacement of a wolverine from its den (Brower 1997 in USDOI BLM 1997). Wolverines have been sighted to the west of Teshekpuk Lake, along the Colville, Kikiakrorak, and Kogosukruk rivers, and Judy and Fish creeks.

Under Alternative A, Teshekpuk Lake would not be available for leasing. There would be no summer seismic exploration on the lake, and therefore, no disturbance of terrestrial mammals near the lake due to such activity.

Exploratory Drilling

Impacts to terrestrial mammals from exploratory drilling would be similar to those caused by seismic activity, though affecting a smaller area and lasting longer at one location. Habitat impacts would be negligible, as exploratory drilling would occur during the winter on frozen tundra, packed snow roads, ice roads, and ice airstrips, and would affect a very small proportion (less than 2 percent) of the total area.

Potential causes of disturbance to terrestrial mammals from exploratory drilling include surface vehicular traffic, humans on foot, fixed-wing aircraft traffic and the noise of the drill rig itself. These activities may cause short-term (a few minutes to 1 hour) displacements of and disturbance to terrestrial mammals, or they may cause abandonment of the local area for the remainder of the winter. Camps at drill sites could result in localized disturbance and displacement of terrestrial mammals for several weeks to months.

Exploratory drilling operations and ice roads would traverse Teshekpuk Caribou Herd caribou wintering areas and could encounter some wintering caribou from the Western Arctic Herd, although most Western Arctic Herd caribou winter a considerable distance to the south of the NPR-A (Dau 2005). Any caribou in the immediate vicinity of the activity would be disturbed, possibly having a negative effect on their energy balance, hormonal status, and calving success, due to prolonged stress. Because these animals are mobile and the operation would be temporary, it is not expected that there would be any long-lasting effects on caribou. However, as with effects of disturbance by seismic operations, this assumption has not been tested and conditions for winter survival vary from year to year. It is possible that this disturbance could have an additive effect on natural winter mortality.

The winter distribution of muskoxen and moose is such that exploratory drilling activities would be unlikely to have any impacts on these species unless they occurred near riparian areas, such as the Colville River. Under such a circumstance, impacts would likely include short-term displacement or disturbance of animals, as described above, but may result in abandonment of winter habitat and negative effects on energy balance. Impacts to arctic fox, grizzly bear, and wolverine would be similar to impacts from seismic activities, but would be more frequent and/or longer in duration. There would be a greater potential for foxes to be attracted or habituated to camps associated with drill sites, as they would be in place for one to two months, rather than a week or less.

Oil and Gas Development

The primary effects of oil or gas development on terrestrial mammals would result from the construction of facilities, such as roads and pipelines; motor vehicle traffic within the oil or gas field(s) and on connecting roads; foot traffic near facilities and camps; aircraft traffic; crude-oil and fuel spills contaminating tundra, stream, and coastal habitats; and habitat alteration associated with gravel mining and infrastructure construction.

Caribou – Although much of the construction associated with oil or gas development would occur primarily during winter, caribou are often present in the NPR-A (especially on the coastal plain) during that season. Operation of developments would bring year-round facilities and activities within caribou summer range. Caribou could be disturbed by traffic, humans on foot, and low-flying aircraft (Calef et al. 1976; Horejsi 1981; Shideler 1986; Tyler 1991; Murphy and Lawhead 2000). The response of caribou to disturbance would be highly variable, ranging from no reaction to violent escape reactions, depending on: distance from human activity; speed of the approaching disturbance source; frequency of disturbance; sex, age, and physiological condition of the animals; size of the caribou group; and season, terrain, and weather. Caribou cow and calf groups appear to be the most sensitive to traffic, especially in early summer during and immediately after calving, while bulls appear to be least sensitive all year.

Tolerance to aircraft, ground vehicle traffic, and other human activities has been reported in several studies of caribou and other hoofed-mammal populations in North America (Johnson and Todd 1977; Davis et al. 1980). It appears that caribou can habituate to structures, noise, and odors, but habituate slowly or not at all to humans on foot or large moving objects such as vehicles (Murphy and Lawhead 2000). Most of the caribou in the NPR-A are from the Teshekpuk Caribou Herd and Western Arctic Herd caribou herds, however, and have had less exposure to human activities and are less likely to be tolerant of disturbances than animals habituated to activities at Prudhoe Bay.

Development in the Teshekpuk Caribou Herd caribou calving grounds could displace some calving animals within 2.5 miles of roads (Cameron et al. 1981, 1983, 1992, 2002). In the Kuparuk-Milne Point area, the relative distribution of calving has shifted away from development facilities (Lawhead et al. 1997; Wolf 2000). Cameron et al. (2002) evaluated changes in the distribution of calving Central Arctic Herd caribou associated with the Kuparuk-Milne Point area. Before construction of a road system to Milne Point, caribou were found in a single, more or less continuous concentration, roughly centered where the road was later built. After construction of the road, a bimodal distribution with separate concentrations of animals east and west of the road was apparent. Ground observations of caribou within the Kuparuk area from 1978 to 1990 indicated that caribou increasingly avoided zones of intense activity, especially during the calving period (Smith et. al. 1994). Lawhead et al. (2004) reported that maternal caribou with calves were displaced from areas near both the Tarn and Meltwater roads during calving and up to two weeks after calving. Very few calves were observed within 1.2 miles of either road during the calving period, and densities appeared to be reduced as far away as 2.4 miles. Traffic convoying on the Meltwater road was not effective at reducing calving displacement to less than 1.2 to 2.4 miles, or reducing the disturbance reactions of caribou within 1,640 feet of the road. Data analyzed by Cameron et al. (2002) suggested that having roads too closely spaced could completely displace calving activity within an oil or gas field complex. Other studies (Roby 1978; Cameron et al. 1981, 1983, 1992; Pollard and Ballard 1993) and literature reviews (Cronin et al. 1994, 1998) indicate some seasonal avoidance of habitats within three miles of existing Prudhoe Bay area facilities by cows and calves during calving and early post-calving periods (May through June).

Movements of some cows and calves across roads would also likely be reduced, and cow caribou might avoid crossing the roads during the calving season. Some Teshekpuk Caribou Herd caribou movements during the insect-relief season (late June to mid-August) would likely be affected by pipelines and road traffic. The most critical corridors for movement to the coastal insect-relief area are through the narrow areas between Teshekpuk Lake and the Kogru River to the east and between the lake and Smith Bay to the northwest (Person et al. 2007; Yokel et al. 2009). These areas would be open to leasing by 2018 under Alternative A. Caribou must pass through them to get to and from insect-relief areas. The area to the east of Teshekpuk Lake is a particular problem because nearly all of the parturient cows pass through this area either shortly before or after calving (Person et al. 2007). Any development that occurs on the limited amount of habitat that is used by caribou migrating through this corridor would likely affect caribou movements. Development in the corridors could result from oil or gas finds in the area of the corridors or from a pipeline that would come from oil or gas fields north of the lake. Under Alternative A, development within the corridors themselves would be limited to pipelines, but field development could occur north of Teshekpuk Lake. The result would be a potential for oil and gas development activities to affect caribou use of these corridors. Additionally, the area north of the lake that would allow leasing extends to the coast, except near Cape Halkett. While a setback from the coast is stipulated (Lease Stipulation K-6), development in the coastal area would likely impact caribou use of insect-relief areas near the coast.

Studies done over the last decade have indicated that Teshekpuk Caribou Herd caribou show high fidelity to the calving area near Teshekpuk Lake and that caribou that calve in the traditional calving area have much higher calving success than caribou found outside the area. Collared caribou that were found within the areas protected under the 1998 record of decision for northeast NPR-A (USDOI BLM and Minerals Management Service 1998) during calving season had much higher calving success than caribou found outside the areas. In surveys conducted from 1994 through 2003, 155 of 171 (91 percent) Teshekpuk Caribou Herd caribou that calved successfully calved within these protected areas. Of the 195 caribou cows that were found within the protected areas, 79 percent calved successfully. Of the 65 cows that were found outside the protected areas during calving season, 25 percent calved successfully (Carroll et al. 2005). This relationship held up through 2009 (Parrett 2010; pers. comm.), but not 2010, when an unusual distribution of calving caribou occurred, perhaps due to heavy snow and a late snow melt-off that year.

If the Teshekpuk Caribou Herd is partially displaced from its calving area, as the Central Arctic Herd has been, or if caribou are impeded from reaching the calving area, recent surveys indicate that calving success would most likely be reduced. While there have been no experiments conducted with the Teshekpuk Caribou Herd to determine whether oil or gas development in the calving area would displace caribou or affect the productivity of the herd, caribou behavior during 1997 and 2001 suggest oil or gas development in the Teshekpuk Caribou Herd calving area could impact caribou. During 1996–97, most of the herd migrated much farther south than usual, and many cows arrived late to the calving area. Only 8 of 21 collared caribou were found in the calving area during calving time, and 6 of these calved successfully. Of the other 13 collared cows, only one calved successfully for an overall successful calving percentage of 33 percent. In 2001, heavy snow and a late snow melt-off slowed the migration and only 16 (44 percent) of 36 collared cows calved successfully. Calving success for collared cows that did make it back to the calving area in 2001 was much better (88 percent) than cows that did not make it back (10 percent). This suggests that if oil or gas development takes place in such a way that it displaces caribou from the calving area or interferes with their ability to get to the calving area, it could have an effect on productivity and population numbers (Carroll 2003; Carroll et al. 2005). Although controversy exists over whether population-level effects have been demonstrated for the Central Arctic Herd following displacement from portions of its calving range (Cronin et al. 1998; Cameron et al. 2005), the most recent study of Central Arctic Herd productivity in the oil fields suggests that habitat quality in the calving area in one year may affect calf size at birth in the following year (Arthur and Del Vecchio 2006). Calf size at birth, in turn, influences calf size at the end of the first summer, which has consequences for survival through the following winter.

Wilson et al. (in review) depicted "high quality" calving habitat for the Teshekpuk Caribou Herd in the NPR-A, using caribou location data and resource selection functions. Using this distribution of calving habitat, three hypothetical scenarios for oil and gas development in the northeastern portion of the NPR-A, and a method to discount habitat quality as a function of distance from infrastructure based on data from Cameron et al. (2005), Wilson et al. (2011) showed that significant portions of high-quality calving habitat could be lost to the Teshekpuk Caribou Herd as a result of development. Wilson and Loya (2012) and Wilson (personal communication) suggest through further modeling efforts that the remaining high-quality calving habitat (i.e., not lost to development of roads or pads) would be 78 percent (95 percent confidence interval: 70-84 percent) for Alternative A. Due to various assumptions made in the model and the limited variables used both in defining high-quality calving habitat and the distributions of oil and gas accumulations, there is some risk involved in using these model results as accurate estimates of habitat loss. They do have value, however, as a means to quantitatively compare the alternatives' impacts to caribou calving habitat. The level of calving habitat loss at which population level effects would result remains to be determined.

The Central Arctic Herd caribou core calving range lies outside of the NPR-A, and that of the Western Arctic Herd is in the Utukok uplands of the southwestern NPR-A, an area unavailable for leasing under Alternative A. The Teshekpuk Caribou Herd caribou calving area, however, is concentrated in the northern section of the NPR-A near Teshekpuk Lake. Under Alternative A, no permanent oil and gas surface facilities would be permitted in the Southern Caribou Calving Area (approximately 240,000 acres) south and southeast of Teshekpuk Lake or the Caribou Movement Corridors (approximately 60,500 acres) between Teshekpuk Lake and the Kogru River on the east and the lake and Smith Bay on the northwest. Additional lease stipulations would limit development to a total of no more than 2,100 acres in the approximately 378,700-acre region north and northeast of Teshekpuk Lake.

Under these conditions, development under Alternative A would have the potential to affect only a portion of core calving habitat for the Teshekpuk Caribou Herd, but a substantial portion nonetheless. On-site development in this area could affect caribou movements or cause displacement of calving caribou. This may result in reduced use or the loss of some core calving habitat, which could then affect Teshekpuk Caribou Herd productivity.

In some years, 5 to 10 percent of the Western Arctic Herd caribou may winter on the North Slope. Depending upon the location of oil development infrastructure, movement of both Teshekpuk Caribou Herd and Western Arctic Herd caribou from winter range to calving grounds could be hindered by oil development. The level of effect would depend upon the level of development. An appropriately elevated pipeline with no associated road would have little effect on movement between winter habitat and calving grounds (Lawhead et al. 2006). A road and associated traffic would have a greater impact. Pregnant caribou could be delayed in reaching the calving grounds because of delays in crossing roads or attempts to detour around roads or oil or gas fields. Calving en route to calving grounds could result in reduced calf survival (Carroll et al. 2005).

One issue arising from oil or gas field development is the ability of caribou to move freely through the fields to insect-relief habitats. Caribou under extreme insect harassment initially move rapidly to insect-relief habitat. For the Teshekpuk Caribou Herd caribou, this is often coastal areas of the NPR-A from west of Barrow to Smith Bay, and more importantly to the north and east of Teshekpuk Lake. After reaching these habitats, caribou often continue to move rapidly and may cover long distances. Caribou generally react less to disturbance when under the stress of extreme insect harassment. The stress of human disturbances at this time may be additive to that caused by insect harassment.

When insect harassment abates, caribou drift inland to better foraging areas. At this time, they are more reactive to disturbance and infrastructure, and activities in oil or gas fields or roads between fields could delay or alter movement of caribou from coastal insect-relief areas to foraging habitat further inland. Impaired movement between insect-relief habitat and inland foraging areas could reduce food intake and slow rates of cow and calf weight gain (Smith 1996). The probability of producing a calf is directly related to body weight and fat content of females during the previous autumn (Cameron et al. 2000). Since reproductive success of caribou is highly correlated with nutritional status (Cameron et al. 2002), there could be reproductive consequences from extensive disruption of caribou during the insect-relief season. In some of the insect-relief area, permanent development would be prohibited under Alternative A. In much of the rest of it oil and gas activity would be restricted in ways to reduce impacts on caribou during the insect season.

Cameron et al. (1995) noted that reports of insect-harassed caribou aggregations along the Beaufort Sea Coast and completely traversing the Prudhoe Bay complex, as reported in the 1970s, had become rare. An analysis of the distribution of radio-collared female Central Arctic Herd caribou from 1980 to 1993 suggested that caribou use of the oil field region at Prudhoe Bay had declined considerably from that observed in the 1970s (Cameron et al. 2002). However, the Prudhoe Bay field was not designed to facilitate caribou movement. It is complex and has many older pipelines that are less than 5 feet above the ground. Movement of insect-harassed caribou through the Kuparuk oil field has been examined in several studies (Johnson and Lawhead 1989; Lawhead et al. 1994; Smith et al. 1994). In the Kuparuk oil field, where all pipelines are elevated a minimum of 5 feet above ground, mosquito-harassed caribou were able to pass through the field on their way to and from insect-relief habitat, although they typically detoured around drill pads and were often delayed up to several hours at road crossings. Smith et al. (1994) monitored caribou movement in relation to roads and increasing development in the Kuparuk Area from 1978 to 1990. They found that groups of mosquito-harassed caribou were deterred from crossing roads with higher levels of vehicular traffic. Over the 12 years of the study, a change in access to the oil field area by insect-harassed caribou occurred. During the early years of construction, large insect-harassed groups of caribou approached the road from the middle section. By the end of the study, most large groups were observed at the extremes of the road transect, indicating that caribou might have been avoiding the core areas of industrial activity.

Development in the Teshekpuk Caribou Herd caribou insect-relief habitat would be restricted under Alternative A, as a result of several of the lease stipulations that would apply. When mosquito numbers decline and oestrid fly harassment increases in mid-July, the large aggregations of caribou generally disperse into smaller groups of animals seeking insect-relief habitats, such as unvegetated and elevated sites. Coastal areas apparently provide little relief from fly harassment (Ballard et al. 2000). Gravel pads and roads are sometimes used as fly-relief habitat by caribou (Johnson and Lawhead 1989; Pollard et al. 1996b). Oestrid flies are less common in shade than in sunlit areas (Pollard et al. 1996a), and caribou sometimes use the shade of elevated pipelines and buildings to escape from flies (Murphy and Lawhead 2000). In the NPR-A, the majority of Teshekpuk Caribou Herd insect-relief habitat during the oestrid fly season is located around Teshekpuk Lake, although caribou tend to be more dispersed than they are during the mosquito season. However, caribou do range farther south and west during this period in search of relief, and they may use large areas where development would not be so restricted, as near Teshekpuk Lake.

Western Arctic Herd insect-relief habitat occurs in the southwestern NPR-A, which would be unavailable for leasing, and thus, unaffected under Alternative A. Central Arctic Herd caribou occur in only the extreme northeastern NPR-A, only in the mid- to late-summer, and only in some years. Consequently, impacts to the Central Arctic Herd during insect-relief season would range from none to minor during that season, and none in other times of the year. For these reasons, impacts to Central Arctic Herd caribou from any of the alternatives will not be analyzed further.

If gas pipelines were to be buried, they would have no effect on caribou movements, but oil pipelines would likely be raised and gas pipelines may, as well. Curatolo and Murphy (1986) evaluated the ability of caribou to cross roads and pipelines. They concluded that crossing success was reduced where pipelines were adjacent to heavily traveled roads (greater than 15 vehicles per hour). Isolated pipelines or roads had lesser effects on crossing success. Groups did eventually cross the roads and move through the oil field. For caribou in the Prudhoe Bay and Kuparuk oil fields and pipeline-road corridors, the greatest human-caused influence on behavior and movement is vehicle traffic (particularly high traffic levels, such as 40 to 60 vehicles per hour, or traffic levels of greater than 15 vehicles per hour) within the pipeline-road corridors (Murphy and Curatolo 1984; Lawhead and Flint 1993). Caribou are hesitant to cross the Dalton Highway and other roads on the oil fields because of the traffic (Lampe 1997 in USDOI BLM 1997). A decline in the frequency with which caribou cross pipeline corridors is attributed to high traffic levels on the adjacent road (Curatolo 1984). Caribou generally hesitate before crossing under an elevated pipeline, and may be delayed in crossing a pipeline and road for several minutes or hours during periods of heavy road traffic; however, successful crossings do occur. Caribou have returned to areas of previous disturbance after construction was complete in other development areas (Hill 1984; Northcott 1984).

It is assumed that any pipeline from oil fields in the NPR-A would connect to the Trans-Alaska Pipeline System through facilities at the Kuparuk oil field, with the exception that an oil field at Umiat could connect to the Trans-Alaska Pipeline System by heading east from Umiat to Trans-Alaska Pipeline System Pump Station 2. Gas pipelines are assumed to join at a hub at Inigok and then proceed through a single gas pipeline to the vicinity of Trans-Alaska Pipeline System Pump Station 1. Any pipelines would be constructed during winter using ice roads, and no permanent road would be built.

During construction, air traffic would include several flights per day, which could temporarily disturb some caribou within about a mile of the pipeline. It is expected that disturbance effects on caribou would be short-term, interference with their movements would be temporary (a few minutes to less than a few days), and they eventually would cross the pipeline area. Also, disturbance reactions would diminish after construction was completed. Oil or gas field facilities (other than pipeline) would not be located within 500 feet of most fish-bearing waters, and not within one-half to three miles of major stream drainages, depending on the river segment involved.

The physical presence of a pipeline alone would probably have a minimal effect on the behavior, movement, or distribution of caribou. Even during winter, pipelines elevated at least 7 feet above ground may have adequate clearance between any snowdrifts and the pipe to allow caribou passage (Carruthers and Jakimchuk 1987). This winter effect has not been studied on the North Slope, however, but only in central Alaska with the Nelchina Herd.

Under Alternative A, it is assumed that 12 central processing facilities and 16 additional production pads for oil, and 27 gas compressor facilities and another 60 production pads for gas would be distributed throughout the northern two-thirds of the NPR-A. Development of oil or gas fields could result in impacts to wintering Teshekpuk Caribou Herd caribou; Western Arctic Herd caribou are unlikely to be encountered during winter, because most winter south of the Brooks Range. Depending on the location of the development, some Teshekpuk Caribou Herd caribou migration movements could be temporarily disrupted or diverted by air and surface traffic along pipelines and roads within the oil field. Wintering animals could also be temporarily disturbed or avoid the development area. Repeated disturbance of the same animals during the winter could have negative impacts on the energy balance of individual animals, which might result in lowered calving success or even increased winter mortality.

Development of oil or gas fields would require large amounts of gravel (up to 2 million cubic yards each). Gravel is a scarce resource in the northern part of the NPR-A, and if local sources of gravel were not available, alternative strategies could be used. These may include barging construction materials to coastal staging areas for later transit over ice roads, processing bedrock for construction materials, using year-round ice pads, or reusing gravel from previous Husky drill sites. Gravel extraction (outside of the NPR-A), hauling of the gravel on ice roads (into the NPR-A), and deposition of gravel in the lease areas would occur in winter when caribou are less mobile and often present in large, loose aggregations. These activities could result in local disturbance or displacement of some animals, but would not likely affect the overall distribution of caribou. The loss of relatively small areas of tundra habitat to gravel pads, roads, and other alterations generally has not had major effects on the Central Arctic Herd caribou, and would likely have a minimal impact on the Teshekpuk Caribou Herd and Western Arctic Herd caribou. It is important to note, however, that functional loss of habitat would be greater than the number of acres indicated as the actual development footprint. Wolfe (2000) suggested that when caribou in the Central Arctic Herd avoided areas within 2.5 miles of roads (calving season only), the functional habitat loss increased from 2 percent of the calving area (the immediate footprint of roads and gravel pads) to 29 percent.

Oil and gas development within the NPR-A could introduce for the first time such infrastructure and activities into the winter range of a North Slope caribou herd (Teshekpuk Caribou Herd). Previously, no North Slope caribou herd has been exposed to oil and gas activities year-round. The Teshekpuk Caribou Herd has experienced seismic exploration and activities near villages for many years, and some herd members on the periphery of the range have been exposed to oil field facilities in some years, but there is no evidence as yet of adverse effects other than increased hunting mortality for those animals close to villages. It is not known what population effects might occur if the majority of the herd were to have year-round contact with oil and gas facilities and activities. Despite the current lack of evidence regarding adverse effects from seismic exploration and village contact, negative effects on caribou energy budgets during winter could result from this new situation. Such an effect could be manifested through increased winter mortality itself, or a reduction in calf productivity.

Muskoxen – Potential effects of oil and gas development activities on muskoxen include displacement and disturbance of individual animals, direct habitat loss from gravel mining in river floodplains and at oil or gas field facilities, and indirect habitat loss through reduced access caused by physical or behavioral barriers created by roads, pipelines, and other facilities (Garner and Reynolds 1986; Clough et al. 1987). Muskoxen may be more exposed to oil exploration and development than caribou, because they tend to remain year-round in the same habitat area (Jingfors 1982); conversely, muskoxen may be able to habituate to these activities because of this year-round exposure. Muskoxen have been exposed to the Trans-Alaska Pipeline System, the Dalton Highway, and the Kuparuk and Alpine oil fields with the expansion of their range west from the Arctic National Wildlife Refuge and the Kavik River. If populations expand farther within the NPR-A, they could move into additional areas of development. Construction of oil or gas pipelines in the Teshekpuk Lake area, following the end of the deferral, could result in temporary disturbance of mixed-sex groups of the known muskoxen in that area. Repeated disturbance of the same group during the winter, by air traffic for example, could negatively affect the energy balance of individual animals and potentially contribute to winter mortality. Under Alternative A, lease stipulations and required operating procedures are in place to minimize impacts to muskoxen—for example, by prohibiting permanent facilities within 500 feet to 3 miles of waterbodies, prohibiting hunting by employees, limiting ground transportation, and controlling air traffic.

Moose – Moose occur in low densities in the NPR-A during the summer, and are concentrated in major drainages along the eastern edge of the NPR-A in the winter. Unless an oil or gas field were to be developed in the extreme east of the NPR-A near the Colville River, such as the Umiat oil field, development would be unlikely to impact moose. A number of studies show that the Trans-Alaska Pipeline System has no major effect on moose movements and habitat use near the pipeline (Sopuck and Vernam 1984, 1986; Eide et al. 1986). In one study, 94 percent of moose successfully crossed the pipeline corridor, and moose distribution was independent of distance from the pipeline (Sopuck and Vernam 1986). However, moose preferred to cross pipelines elevated above 5 feet (Sopuck and Vernam 1984). Under Alternative A, neither in-field oil or gas pipelines, a crude oil pipeline connecting with the Trans-Alaska Pipeline System, nor a high-pressure gas line from Inigok, all of which would be elevated at least 7 feet, would be expected to affect moose habitat use and movement regardless of the location of the field(s). Air and surface traffic could also disturb moose, but the number of animals affected would likely be small, and no impacts to the population would be anticipated; any air or surface traffic disturbance should be of short duration.

If gravel were mined from riverbeds in the NPR-A, a temporary displacement and disturbance of moose could occur. Borrow pit operations could potentially destroy or degrade up to 1,415 acres of moose habitat, if all were located in riparian habitats.

Dall Sheep – Dall sheep would not be affected by oil or gas activities under Alternative A because the area along the extreme southern edge of the NPR-A, where they may occur, would not be available for oil or gas leasing.

Grizzly Bears – Major sources of noise include construction of roads, installation of crude oil pipelines, pump and compressor stations, gravel mining, and camp and drilling operations. These activities could disturb grizzly bears within a few miles of the noise sources and could keep bears from accessing their preferred denning sites. Industrial activities and human presence could also cause potentially serious disturbances to hibernating bears, particularly maternal females and cubs. In one study, seismic activities within 0.9 to 1.1 miles of a grizzly bear den caused changes in heart rate and movement of the female bear and cubs (Reynolds et al. 1986). However, this seismic testing involved the detonation of dynamite, a technique that would not be used under the scenario provided here. Also, none of the bears in that study left their dens. The investigators suggest that seismic testing activities within about 600 feet of the den may cause abandonment of the den. A similar effect could occur from construction activities within 600 feet of dens. In a study of maternal denning of polar bears and their cubs (a comparable species), disturbances from capture, marking, and radio tracking did not affect litter sizes or the stature of cubs produced. This tolerance by bears, and the fact that maternal investment in the denning effort increases through the winter, indicate that spatial and temporal restrictions on development activities could prevent abandonment of the dens (Amstrup 1993).

Human scent and other noises could also disturb bears. When grizzly bears first encounter humans on foot, their initial response is to flee; responses to ground-based human activities are stronger than responses to aircraft, especially when encounters occur in open areas such as the North Slope (McLellan and Shackleton 1989). The increase in human presence and resulting encounters with grizzly bears associated with recreation and tourism are temporary in nature. The establishment of permanent settlements (oil fields, mines, etc.), however, usually leads to human-bear encounters on a regular basis and to conflict, particularly if bears learn to associate humans with food (Harding and Nagy 1980, Schallenberger 1980, Miller and Chihuly 1987, McLellan 1990). Grizzly bears initially avoid human settlements because of the noise and disturbance (Harding and Nagy 1980), but, if the area includes an important food source, some bears are likely to habituate to the noise and human presence, leading to an increase in encounters. Individual bears, especially females with cubs, vary in the degree of habituation-tolerance to human presence, and some would continue to avoid areas when humans are present (Olson and Gilbert 1994). Although studies show cub survival is higher among bears using anthropogenic food sources in the oil field region (Prudhoe and Kuparuk), this effect is countered by the fact that these bears have a lower than normal survival rate after becoming sub-adults (Shideler and Hechtel 2000).

The attraction of grizzly bears to garbage or other food odors at oil and gas facilities has led to encounters in which the need to protect workers results in the loss of bears (Schallenberger 1980). Once bears become conditioned to the availability of human sources of food, measures to reduce this availability by improved garbage handling are not always effective (McCarthy and Seavoy 1994). The bears respond by making an extra effort to get to the food sources that they are conditioned to having.

Under Alternative A, oil and gas exploration and development would likely attract some grizzly bears to oil production facilities, and could result in the loss of some bears due to interactions with humans, including mortality on roads. In addition, bears could be subjected to increased hunting pressure through improved access or increased human presence associated with oil and gas development. The level of impacts to bears would be dependent upon the location of the oil or fields. Bears are much less common in the Arctic coastal plain than in the foothills or mountains of the central and southern parts of the NPR-A. Oil development in the area with the highest potential for oil reserves (the north) would initially have fewer impacts on bears than development in the central portion of the NPR-A, and no leases would be offered for sale in the southern portion under Alternative A. However, if bears were attracted to oil development, impacts could increase over time. Shideler and Hechtel (2000) estimated bear densities in the oil field region (Prudhoe Bay and Kuparuk river Unit) to be 1.5 bears per square mile, more than twice the highest density estimate for the Arctic coastal plain. Because this higher density could not be attributed to anthropogenic food sources, the authors speculated that the oil field region was higher quality habitat than other parts of the Arctic coastal plain. Gas development is assumed to be of greater magnitude than oil development in all parts of the NPR-A, where leases would be offered under Alternative A. The total of central processing facilities and gas compressor facilities is assumed to be 42, so there would be many opportunities for bears to come in contact with these developments.

Gravel mining in riparian corridors along major rivers could result in the disturbance and loss of up to 1,415 acres of bear habitat. Shideler and Hechtel (2000) found that bears often used riparian habitats on the North Slope. On average, 51 percent of their observations of radio-collared bears were in riparian corridors along major rivers and streams.

Lease Stipulations E-2, K-1, and K-7, and Required Operating Procedures C-1, C-2, and E-8 restrict industrial activities close to riparian habitat and bear dens, and would reduce impacts.

Wolves – Potential effects on wolves include short-term disturbances from air and surface traffic and human presence, and increased hunting and trapping pressure through improved access or increased human presence associated with oil or gas development. If caribou abundance decreased substantially as a result of development, wolf abundance could also decrease. Wolves are generally not abundant in the portion of the NPR-A in which lease sales would be offered under Alternative A, with the possible exception of the area near the Colville River. Therefore, oil and gas development under Alternative A would likely impact a minimal number of wolves.

Wolverines – The potential effects of oil or gas development on wolverines could include disturbance from air and surface vehicle traffic, increased human presence, and habitat alteration. Because wolverines are considered a shy and secretive species, they could be sensitive to oil or gas exploration and development activities. Winter seismic activities in the Pik Dunes area south of Teshekpuk Lake caused the displacement of a wolverine from its den (Brower 1997 in USDOI BLM 1997). If caribou abundance were affected by oil or gas development, wolverines could also be affected. Decline in the distribution and abundance of wolverines in Canada was attributed to increased harvest and decline in caribou populations (Van Zyll de Jong 1975). Alteration of riparian habitats through gravel excavation or pipeline construction could affect wolverines, especially during the winter, when these habitats provide cover and important hunting areas. Under Alternative A, some wolverines could be displaced near (within a few miles of) oil or gas field facilities. Lease stipulations and required operating procedures that control or prohibit development activities near riparian areas in the vicinity of the Colville River would help mitigate impacts on wolverines.

Foxes – Oil or gas development activities could affect arctic and red fox populations by increasing the availability of food and shelter. Current oil field facilities provide additional food sources for foxes at dumpster sites near the galley and dining halls, and at dump sites (Eberhardt et al. 1982; Rodrigues et al. 1994). Crawl spaces under housing, culverts, and pipes provide foxes shelter for resting and, in some cases, artificial dens (Eberhardt et al. 1982; Burgess and Banyas 1993). Localized oil development activities do not appear to have any dramatic, deleterious effect on arctic fox populations (Eberhardt et al. 1982). A study of den sites and fox productivity near Prudhoe Bay indicates that adult fox densities and pup production are higher in the oil fields than in surrounding undeveloped areas (Burgess et al. 1993). An increase in the fox population associated with oil development could affect some prey species of foxes (such as ground-nesting birds and molting waterfowl) in the development area and over a region larger than the oil field itself. Standard waste management practices and employee training would reduce the likelihood that foxes would be attracted to oil field facilities.

Effects of Abandonment and Reclamation

Abandonment and reclamation activities would disturb and displace terrestrial mammals in a manner similar to that associated with construction. The intensity of the disturbance might be less than during construction, because it is possible that caribou, muskox, and other terrestrial mammals would have become habituated to road and air traffic over the course of construction and operation of the facilities. Some individuals could be killed by collisions with road traffic. If roads were left in place and maintained in useable condition upon abandonment, they could continue to provide improved access to hunting areas, with consequent hunting pressure on caribou and other subsistence species. Revegetation of the roads, pads, and airstrips, if they were left in place, would facilitate reclamation of habitat. Plant communities on these raised gravel structures would likely be different from those that prevail in adjacent areas and may include non-native, invasive species. However, these pads, roads, and airstrips could provide some insect-relief habitat for caribou. If gravel fill was removed and the site revegetated with species similar to the surrounding plant communities, caribou, and possibly other terrestrial mammals, would use the area. Foam insulating materials that could be used in pad construction could be broken up in the course of removal. If some of this foam escapes being cleaned up, it may be used by foxes as denning material. Depending on the material's toxicity and the amount ingested by foxes, this could cause mortality, though the numbers of foxes killed would likely be very small. Overall, the impacts of abandonment and reclamation activities would be measured as impacts to individuals; no adverse impacts to populations are expected.

Effects of Spills and Gas Releases

Spills could involve crude oil, refined products, produced water, or seawater. Typical refined products that are spilled on the Alaska North Slope include aviation fuel, diesel fuel, engine oil, fuel oil, gasoline, grease, hydraulic oil, transformer oil, and transmission oil. The extent of environmental impacts would depend upon the type, location and amount of materials spilled or released, and the effectiveness of the response. The majority of small spills would be contained on the gravel pad and would have no impact on terrestrial mammals or their habitat. Gas releases could occur at well sites (i.e., over a gravel or ice pad) or from pipelines, the great majority of which would be over tundra.

Caribou and other terrestrial mammals could be coated with oil (in the case of a blow-out, or from lying on oiled tundra) or ingest contaminated vegetation. Adult caribou, moose, and muskoxen that were to become oiled would not likely suffer from a loss of thermal insulation during the summer, although toxic hydrocarbons could be absorbed through the skin or inhaled. However, the oiling of young calves could reduce thermal insulation, leading to their death (USDOI BLM and Minerals Management Service 1998). Oiled caribou, moose, and muskox hair would be shed during the summer before the winter fur was grown. If animals were oiled in the winter after shedding their summer coats, oiling may affect thermal insulation, resulting in winter mortality. No documented caribou deaths have been attributed to spills associated with the Trans-Alaska Pipeline System. Toxicity studies of crude-oil ingestion in cattle indicate that substantial weight loss and aspiration pneumonia leading to death are possible effects (Rowe et al. 1973). Exposure of livestock (horses and cattle) utilizing grazing lands with oil development has resulted in mortality and morbidity (Edwards 1985). Exposure could involve heavy metals, salt water, caustic chemicals, crude oil, and condensates. In cattle, this exposure has been shown to result in a wide variety of symptoms including effects on the central nervous system, cardio-pulmonary abnormalities, gastrointestinal disorders, inhalation pneumonia, and sudden death. Caribou, moose, and muskox that become oiled by contact with a spill in contaminated lakes, ponds, rivers, or coastal waters could die from toxic hydrocarbon inhalation and absorption through the skin. In addition to acute toxicity, mortality from chronic effects could occur well after a spill.

Spill/release response would disturb terrestrial mammals; some oiled animals could be captured for treatment, while non-oiled animals could potentially be hazed from the area under agency guidance. The extent of the disturbance would depend upon a variety of factors, including spill/release size and location, response actions, and season. Aircraft or overland vehicles would temporarily disturb terrestrial mammals present in the vicinity of the spill/release. Response to disturbance could last from a few minutes to a few hours. Larger and more mobile terrestrial mammals would be temporarily displaced by human activity around the cleanup site; displacement could last for a few days to a few weeks. It is not expected that these disturbance impacts would have population-level effects on any terrestrial mammals.

If an oil spill from a pipeline or a spill large enough to escape from a gravel facility pad were to occur, some tundra vegetation would become contaminated. Caribou, moose, and muskoxen probably would not ingest oiled vegetation because they tend to be selective grazers and are particular about the plants they consume (Kuropat and Bryant 1980). For most spills, control and cleanup operations (ground traffic, air traffic, and personnel) at the spill site would frighten caribou, moose, and muskoxen away from the spill and limit the likelihood that these animals would graze on the oiled vegetation. In most cases, onshore oil spills would not be expected to affect caribou, moose, and muskoxen through ingestion of oiled vegetation. For large spills that are not immediately or successfully cleaned up, the potential for contamination would persist for a longer time and there would be a greater likelihood of animals being exposed to the oil. Cleanup success would likely vary depending upon the environment. Over time, any remaining oil would gradually degrade. Although oiling of animals would be unlikely to remain a threat after cleanup efforts, some toxic products could remain for some time. Depending upon the spill environment, a portion of the oil could persist for 5 years (USDOI BLM and Minerals Management Service 1998).

Oil spills on wet tundra would kill the moss layers and aboveground parts of vascular plants, and could potentially kill all of the macroflora at the site (McKendrick and Mitchell 1978) resulting in loss of forage. Damage to oil-sensitive mosses could persist for several years if the site were not rehabilitated. The length of time that a spill would persist would be dependent upon soil moisture and concentration of the product spilled. McKendrick (2000) reported that complete vegetation recovery occurred within 20 years on a wet sedge meadow without any cleanup. At a dry habitat exposed to the same application, vegetation cover was less than 5 percent after 24 years. Winter foraging habitat for caribou would be compromised or destroyed if there were a large oil spill on the ground's surface that affected nonvascular species such as lichens. For the most part, onshore oil spills would be very localized (less than 1 acre) in their effects and would not be expected to substantially contaminate or alter caribou, moose, or muskoxen habitat. However, some local contamination of tundra vegetation would likely occur near production wells and processing facilities. Spills occurring within or near streams and lakes could affect foraging habitat along these waterbodies.

A single gas release occurring with ignition could have thermal effects to approximately 194 acres of tundra vegetation (500-meter radius). The assumed number of gas releases under Alternative A (2.4 = 0.9 incidents per 300 pipe miles times 799 miles of pipe), if ignited, would result in thermal effects to approximately 466 acres of tundra. If a wildfire resulted, additional acreage would burn, the amount depending on season, weather conditions, moisture content of vegetation, and suppression effort. Most North Slope tundra fires are less than 1,000 acres (Racine and Jandt 2008). Total vascular plant cover following lightning-caused tundra fires reached 50–100 percent after 5 to 6 years (Racine et al. 1987). Lichens, however, could take several decades to recover if they can achieve former densities at all under a climate-warming regime (Jandt et al. 2008). Regardless, the burning of 466 acres of tundra vegetation would not affect any population of terrestrial mammals in the NPR-A. No study has attributed mammal population changes to wildfire on the North Slope, even for the few large, lightning-caused fires recorded in the last 55 years.

Grizzly bears may use coastal streams, beaches, mudflats, and river mouths during the summer and fall for finding carrion. If an oil spill were to contaminate beaches and tidal flats along the Beaufort Sea coast (an unlikely situation under Alternative A), some grizzly bears would be likely to ingest contaminated food, such as oiled birds, seals, or other carrion (USDOI BLM and Minerals Management Service 1998). Such ingestion could result in the loss of some bears through acute toxicity. An oiling experiment on captive polar bears indicated that if a bear's fur becomes oiled and the bear ingests a considerable amount of oil while grooming, kidney failure and other complications could lead to the bear's death (Oritsland et al. 1981). Brown bears on the Shelikof Strait Coast of Katmai National Park (an area contaminated by the Exxon Valdez oil spill) were observed with oil on their fur and were consuming oiled carcasses; one young bear that died had high concentrations of aromatic hydrocarbons in its bile and might have died from oil ingestion (Lewis and Sellers 1991). Anecdotal accounts of polar bears deliberately ingesting hydraulic and motor oil and foreign objects from human garbage sites suggest that both bear species are vulnerable to ingesting oil directly, especially from oiled carrion and other contaminated food sources (Derocher and Stirling 1991). Skin damage and temporary loss of hair can result from oiling of bears, with effects on thermal insulation. Alternative A could result in the loss of a very small number of grizzly bears through ingestion of contaminated prey or carrion, but no population level effects would result.

Furbearers could be affected by spills due to oiling or ingestion of contaminated forage or prey items. These impacts would be localized around the spill area and would not have population-level impacts.

If seawater were used to enhance oil production, a saltwater spill could occur within the NPR-A. According to McKendrick (2000), brine spills kill plants on contact and increase soil salinity to the point that many species cannot survive. Unlike oil, salts are not biodegradable, and natural recovery occurs only after salts have leached from the soil. A spill would have effects on salt-intolerant vegetation near the seawater pipeline, but the amount of tundra habitat affected would be no more than a few acres. Thus, saltwater or produced water spills would not meaningfully affect forage availability for caribou, muskoxen, moose, or other terrestrial mammals in the NPR-A. In cattle, ingestion of saltwater at greater than 10,000 parts per million salt can cause sodium-ion toxicity, and at lower levels, may affect rumen activity (Edwards 1985). In the case of a saltwater spill on tundra habitat, the water would likely be absorbed into the vegetative mat or in wet habitats, diluted with fresh water. Cleanup and rehabilitation activities would likely keep terrestrial wildlife out of the spill area for the short term. Over the long term, mortality of vegetation in the area affected by the spill would make the area undesirable for grazing by terrestrial mammals until the vegetation recovered.

In the event of a natural gas-well blowout or pipeline rupture, there would be a short-term release of gas (less than one day) which could extend downwind for about a half mile and would quickly dissipate once the blowout or leak was stopped. Terrestrial mammals in the immediate vicinity (less than 500 meters) of the release could be killed if ignition were to occur. Natural gas and condensates that did not burn in the release would be hazardous to any terrestrial mammal exposed to high concentrations, but these are unlikely in an open-air situation. Given the small area that would be exposed to the plume and the rapid dissipation of the gas, it is not likely that any animals other than individuals present in the immediate vicinity at the time of the release would be affected. The likelihood of caribou, moose, muskoxen, wolves, or grizzly bears being exposed to toxic amounts of gas and condensates would be negligible.

4.3.9.3 Effectiveness of Stipulations and Required Operating Procedures

Lease stipulations and required operating procedures described in the 2004 Northwest IAP/EIS Record of Decision (USDOI BLM and Minerals Management Service 2004) and the 2008 Northeast SIAP/EIS Record of Decision (USDOI BLM 2008) would reduce the impacts of development under Alternative A.

Several required operating procedures (A-1 through A-7) that specifically address solid and liquid-waste disposal, fuel handling, and spill cleanup should, if properly implemented, substantially reduce the potential effects of oils and other waste on terrestrial mammals. Required Operating Procedure A-8 attempts to minimize conflicts between humans and bears by managing human behavior, and can also be substantially effective. Required Operating Procedure C-1 protects denning grizzly bears by prohibiting heavy equipment within a half mile of dens, and is effective to the extent den locations are known. Required Operating Procedure C-2 addresses overland moves and seismic work, and would minimize alteration of terrestrial mammal habitats. Lease Stipulation D-1 would prohibit exploratory drilling in lakes, streams, lakebeds, and active floodplains unless impacts to wildlife were minimal, thus minimizing impacts to riparian habitats valuable to some terrestrial mammals. Lease Stipulation D-2 would be effective in minimizing surface impacts from exploratory drilling in any location by limiting drilling to temporary facilities such as ice pads, ice roads, ice airstrips, and temporary platforms, unless the lessee were to demonstrate that construction of permanent facilities was environmentally preferable. The setbacks outlined in Lease Stipulations E-2, K-1, and K-2 associated with development near rivers and lakes would provide additional protections for riparian habitat, as would Required Operating Procedure E-8, by potentially reducing the number of material sites developed within floodplains.

Required Operating Procedure E-1 would be effective in protecting wildlife resources by requiring that all roads be designed, constructed, maintained, and operated to create minimal environmental impacts. Required Operating Procedure E-5 would reduce the overall direct loss of habitat to development. Required Operating Procedure E-7 would require that pipelines and roads be designed to facilitate caribou passage by (1) elevating all aboveground pipelines at least 7 feet above the ground, providing better passage during winter when snow is on the ground; (2) burying pipelines; or (3) providing ramps. In addition, Required Operating Procedure E-7(c) would require that a minimum distance of 500 feet separate pipelines and roads, when feasible. If fully implemented, these required operating procedures would be effective in reducing (but not eliminating) the impacts of oil development on caribou movement (Lawhead et al. 2006). Since caribou are sensitive to humans on foot and moving vehicles, there would be some negative effects on their ability to freely move through the area, regardless of how well the field was designed.

Required Operating Procedure F-1 would minimize the effects of low-flying aircraft on terrestrial mammals by requiring an altitude of at least 1,000 feet above ground level (except for takeoffs and landings) over caribou winter ranges (December 1 to May 1), limiting the number of takeoffs and landings in support of operations, and requiring aircraft altitudes of at least 2,000 feet above ground level (except for takeoffs and landings) over the Teshekpuk Lake Caribou Habitat Area (May 20 to August 20). Assuming that aircraft operators were aware of the potential effects of aircraft on wildlife and took the appropriate actions to minimize those effects, disturbance impacts to terrestrial mammals could be effectively reduced.

Lease Stipulations K-5 and K-6 would require that the operator minimize disturbance and hindrance of caribou, or alteration of caribou movements through portions of the Teshekpuk Lake Caribou Habitat Area and the coastal area that are essential for all-season use, including calving and rearing, insect relief, and migration. These lease stipulations would require studies of caribou movement, restrict exploratory drilling, protect major land corridors, require field design that takes caribou movements into account, and require various ground and air traffic controls.

Lease stipulations K-8, K-9, and K-10, which limit the allowable types of oil and gas infrastructure in the Pik Dunes, Kasegaluk Lagoon Special Area, the Caribou Movement Corridors east and northwest of Teshekpuk Lake and the Southern Caribou Calving Area south of Teshekpuk Lake, are expected to minimize disturbance of caribou behavior and interference with caribou movement in those areas. Lease Stipulation K-11 would strictly limit the footprint of surface infrastructure in the area north and northeast of Teshekpuk Lake.

4.3.9.4 Conclusion

Terrestrial mammals that could be affected by management actions under Alternative A include the Teshekpuk Caribou Herd, Western Arctic Herd, and Central Arctic Herd caribou. However, impacts to caribou would be greatly limited, since permanent oil and gas surface occupancy would be restricted in the Teshekpuk Lake area and no leases would be offered for sale in the southwest portion of the NPR-A used by the Western Arctic Herd for calving and insect relief. Caribou could be temporarily exposed to helicopter traffic and other human activities associated with resource inventories, seismic operations, exploratory drilling, and pipeline construction, but such exposure would not be expected to have any effects at the population level. The Teshekpuk Caribou Herd caribou movements within insect-relief areas could be disrupted by oil and gas development activities, which could impact herd productivity. However, most insect-relief habitat in the NPR-A used by the Teshekpuk Caribou Herd would be protected to some extent by lease stipulations and required operating procedures under Alternative A; therefore, any impacts to herd productivity would likely be minor. The Western Arctic Herd caribou could also be exposed to oil or gas development facilities in some localized areas outside their high-density calving and insect-relief habitats. Moose, muskoxen, grizzly bears, wolves, wolverines, and foxes could be locally affected by activities associated with oil and gas exploration and development. There would be minor permanent loss of habitat associated with gravel placement, as well as potential avoidance of areas where development occurs. Noise associated with development would cause a temporary disruption of normal behavior patterns, but would be unlikely to cause any long-term impacts to the animals. Bears and foxes could be attracted to developments, although the attractiveness of developments could be limited by proper waste handling. In general, non-oil and gas management actions would not affect terrestrial mammal populations in the NPR-A, because they would be temporary and of small magnitude. Overall, management actions related to oil and gas may affect some terrestrial mammals, especially caribou, at the population level in the NPR-A, but the evidence from current oil fields provides some cause to dispute this.

Due to the differences in development scenarios between Alternative A and the sum of the preferred alternative from the previous plan for the northeast NPR-A and its updated scenario for northwest NPR-A (USDOI BLM 2008), the probability of population-level effects to any terrestrial mammal species, though still considered low, is higher under Alternative A than in the previous plan. The differences in development scenarios are due to the newer resources assessment by the U.S. Geological Survey (Houseknecht et al. 2010; Attanasi and Freeman 2011), which predicts less total recoverable oil, but spread out over a greater number of fields, and more importantly, not associated with the majority of recoverable gas. This results in a greater number of individual central processing facilities or gas compressor facilities (39 now versus 12 previously), separate gravel production pads (76 now versus 63 previously), gravel runways (38 now versus 12 previously), and miles of gravel roads (701 now versus 620 previously). The current scenario does result in fewer pump or compressor stations (2 now versus 12 previously) and staging bases (4 now versus 6 previously). Overall, the current scenario represents a 16 percent increase in acres of gravel pads or roads and a 65 percent increase in miles of pipelines, spread out over a greater number of individual fields (e.g., a 3.3-fold increase in number of central processing facilities or gas compressor facilities). With this much of an increase, it intuitively follows that impacts to caribou and other terrestrial mammals will be greater, and therefore, have a higher probability of causing population-level effects. Another factor that increases the probability of population level effects in Alternatives C and D of this plan (below) is that BLM's 2008 analysis included development only in the northeast and northwest NPR-A planning areas; it did not include any development in more than 9 million acres in the southwest part of the Reserve.

In general, impacts to mammals from non-oil and gas activities, and from oil and gas activities, would likely be additive, as opposed to compensatory, except in those areas where both types of activities occurred. Impacts to mammals from exploration and development activities would also be additive, except where development occurred in areas previously disturbed during exploration. In areas where two or more activities occurred, overall impacts would reflect those impacts associated with the first activity and any new impacts associated with later activities. Based solely on the total amount of habitat with a potential to be affected, the amount of impacts to mammals under this alternative would be about 39 percent greater than for Alternative B-1, 18 percent greater than for Alternative B-2, 70 percent of those for Alternative C, and 65 percent of those for Alternative D. If oil and gas activities occurred in areas with an abundance of caribou or other mammals, or in areas with high-quality habitat, impacts could be greater than those based strictly on number of acres of habitat impacted either directly (i.e., buried under gravel) or indirectly (e.g., disturbance effects of human activity that extend beyond their sources on gravel pads and roads).

There will be impacts to terrestrial mammals from climate change (section 3.3.6.8 in Volume 1) and from the oil and gas activities expected under Alternative A. Whether the combination of impacts from these two sources is additive or compensatory, or synergistic or countervailing, will depend on where and how development and climate change actually play out in the NPR-A. Climate change could make foraging more difficult for herbivores during winter, possibly causing negative, synergistic effects to mammals when combined with disturbance and displacement of mammals by oil and gas activities. Geographic shifts in the vegetation communities of the NPR-A as a result of climate change could have synergistic impacts to mammals if they resulted in a greater proportion of higher quality habitat for any season overlapping with areas of concentrated oil and gas activity. Alternatively, these vegetation community shifts could move important habitat out of the areas affected by oil and gas activity, resulting in a countervailing effect. Climate change may increase the availability of suitable habitat for some species (e.g., shrub habitat for moose) but may reduce suitable habitat for other species. For any terrestrial mammals affected in the latter way, it is likely that adverse impacts of climate change will be additive to any adverse effects of oil and gas activities, and the two combined may have synergistic adverse effects.

4.3.9.5 Potential New Mitigation Measures

Potential Mitigation Measure 1 – Hazing by aircraft (new subparagraph to Required Operating Procedure F-1)

Objective: Minimize the effects of low-flying aircraft on wildlife, traditional subsistence activities, and local communities.

Requirement/Standard: Hazing of wildlife by aircraft is prohibited. Pursuit of running wildlife is hazing. If wildlife begins to run as an aircraft approaches, the aircraft is too close and must break away.

Potential Benefits and Residual/Unavoidable Impacts: This potential new mitigation measure would reduce any disturbance impacts to mammalian wildlife from aircraft. These impacts, if not mitigated, could additively affect the energy balance of individuals and possibly result in reduced survival or productivity. It will directly and indirectly benefit subsistence activities of local residents by reducing any spooking of animals during a hunt, and by potentially enhancing wildlife populations. This mitigation is not intended to restrict flights necessary to survey wildlife to gain information necessary for population management or population monitoring related to assessing other impacts to wildlife or permitted activities. Despite this mitigation, there would remain some unavoidable disturbance impacts to wildlife from aircraft flights over the NPR-A, including from flights not associated with a BLM authorization.

Potential Mitigation Measure 2 – Chasing wildlife with ground vehicles (new required operating procedure)

Objective: Minimize disturbance and hindrance of wildlife, or alteration of wildlife movements through the NPR-A.

Requirement/Standard: Chasing wildlife with ground vehicles is prohibited. Particular attention will be given to avoid disturbing caribou.

Potential Benefits and Residual/Unavoidable Impacts: This potential new mitigation measure would reduce any disturbance impacts to mammalian wildlife from ground vehicles. These impacts, if not mitigated, could additively affect the energy balance of individuals and possibly result in reduced survival or productivity. Despite this mitigation, there would remain some unavoidable disturbance impacts to wildlife from vehicles, both off and on roads, in the NPR-A. This is because vehicles in the vicinity of wildlife can cause disturbance even without intentionally chasing wildlife.

4.3.10 Marine Mammals

Gray and minke whales are the only two non-special status baleen whales that occur in NPR-A waters. Gray whales can be relatively abundant in NPR-A coastal waters along the Chukchi Sea coast. Minke whales are considered a pelagic species only rarely occurring in coastal waters.

Toothed whales present in NPR-A coastal waters include beluga whales, narwhals, harbor porpoise, and killer whales. Belugas are primarily present during spring migration (i.e., April and May) as they move though openings, known as leads, in the sea ice and during the open water months of summer and autumn, typically from June through October. Harbor porpoises and killer whales are only present during open-water periods. Sightings of narwhals are exceedingly rare. Belugas frequent traditionally used concentration areas in coastal waters of the Arctic for molting (St. Aubin et al. 1990, Frost et al. 1993) or feeding (Huntington et al. 1999). Adjacent to the NPR-A, these areas are primarily near Kasegaluk Lagoon and Kuk Inlet (Frost and Lowry 1990).

Two non-special status "ice seal" species occur in NPR-A marine waters: spotted and ribbon seals. Ice seals are by far the most commonly observed marine mammals in the NPR-A planning area, with ringed seals (a Special Status Species)making up the majority and ribbon seals being rare (Allen and Angliss 2010, Haley et al. 2010, Savarese et al. 2010). Since ribbon seals spend little time in the nearshore environment and are rarely known to haul out onshore or in the landfast ice region (see section 3.3.7 in Volume 1), impact analysis is focused on spotted seals. Ringed and bearded seals are Special Status Species and are discussed in 4.3.11.4.

4.3.10.1 Activities Not Associated With Oil and Gas Exploration and Development

Baleen Whales

Under Alternative A, large whales could be disturbed by non-oil and gas activities only under limited circumstances. Such circumstances could occur during whale migration near the coast when nearshore barge traffic, air traffic, supply camps, or aerial surveys occur (Richardson and Malme 1993). Effects would likely be localized and short-term and would likely have impacts (e.g., whale-ship collisions) on only a few individuals. Effects from shipping are described in great detail, below (see Oil and Gas Exploration and Development Activities; Effects of Disturbance; Noise Disturbance; and Shipping).

Small fuel spills could occur in association with resource inventories and surveys, recreational activities, and overland moves. These spills would most likely involve aviation fuel and other light-fraction hydrocarbons fuels that would likely evaporate and disperse rapidly, and would be cleaned up immediately whenever possible. These small spills would not be expected to impact marine mammals in or near the NPR-A.

Offshore and coastal scientific studies utilize aircraft for surveys and personnel transfer, marine vessels, and in some cases, seismic air gun acoustic arrays to conduct research. These vessels may make calls at Barrow and Wainwright (although there are no ports) for logistical reasons such as exchange of crews and provisions. Barrow and Wainwright are also the primary hubs for aircraft landings and takeoffs. Seismic noise associated with offshore surveys (some of which may have been from research cruises) was detectable in nearshore areas in approximately 10 meters of water east of Point Barrow (National Marine Mammal Laboratory 2009).

Toothed Whales

Activities within the NPR-A, but not related to oil and gas exploration and development, would include permitted air traffic and boating activity; aerial surveys to inventory wildlife or other resources; summer research camps; hazardous material or debris removal; and recreational camps.

Aircraft Use

Helicopters and fixed-wing aircraft are used across the NPR-A for logistical support of research and monitoring camps, surveying, and recreation. Noise from those aircraft, primarily those operating near the coast, may be a source of disturbance. There is very little information about how Arctic toothed whales respond to aircraft or other anthropogenic sound sources, although there are some data for belugas.

Reactions of belugas to aircraft can be variable and contextual. In Russia, groups of feeding belugas seemed less sensitive to disturbance compared to lone whales that dove when an aircraft was approximately 1,650 feet (approximately 500 meters) overhead (Kleinenberg et al. 1964). In Alaska during spring migration, some belugas showed no overt response to fixed-wing aircraft that were within 660 to 990 feet (200 to 300 meters) while others dove abruptly or turned sharply away when the aircraft was 1,518 feet (460 meters) overhead (Richardson et al. 1991). In shallow summering areas in Canada, belugas often swam away or dove in reaction to aircraft (see summary in Richardson et al. 1995).

A study on the reaction of belugas to aircraft during spring migration showed that, belugas reacted to helicopter noise (Patenaude et al. 2002). Most reactions occurred when the helicopter passed within a lateral distance of 250 meters (820 feet) from the animal and at altitudes less than 150 meters (495 feet). Belugas did not exhibit noticeable reactions when a single pass of a helicopter occurred at altitudes over 150 meters (495 feet). Belugas reacted more strongly to a helicopter than to a Twin Otter fixed-wing plane (belugas reacted to a helicopter in 38 percent of the observations compared to 3.2 percent for a Twin Otter).

The reactions of belugas, and presumably narwhals, harbor porpoises and killer whales, to aircraft are variable. Animals generally appear to make only short-term changes in direction or dive in response to sounds produced by aircraft. Frequent and repeated aircraft use along the coast, especially coastal wildlife surveys, could disturb belugas at summer concentration areas or during opportunistic feeding. There are no data about how belugas respond to passing aircraft when under water or about longer-term impacts. Based on limited, short-term data, when belugas are at the surface of the water, infrequent and fleeting disturbance from aircraft would probably be short-term and localized, and unlikely to produce any population-level effects. It is reasonable to assume that impacts to narwhals, harbor porpoises, and killer whales will also be short-term and localized. Given the relatively uncommon to rare occurrence of the latter species in the area, no population-level impacts would occur.

Presence of Camps

There would continue to be numerous camps across the NPR-A during the summer. These camps may be associated with research, recreation, archaeological, paleontological, or site cleanup and remediation. Camps may be present for several days or months. Inland camps would have little to no impact on Arctic toothed whales, but camps near coastal areas, especially near concentration areas, could cause belugas to shift distribution or abandon feeding opportunities. Disturbance could be caused by the presence of people or equipment, including vehicles (i.e., all-terrain vehicles, 4-wheelers) along the beach or bluffs adjacent to the beach. Small camps could occur at any coastal location of the NPR-A, but the most likely large coastal camps would be along the Beaufort Sea coast at Cape Simpson or at Lonely. Disturbance at those locations would likely be restricted to whales that are migrating or moving past the location. Persistent activities in one location might preclude belugas from using that area. Overall, it is expected that the presence of camps could have short-term and localized impacts that are inconsequential to individual—and population-level—health and survival of beluga whales. Harbor porpoises and killer whales are not seen frequently from shore, and narwhals are rarely, if ever seen, thus impacts from coastal camps would likely be minimal.

Removal of Hazardous Material and Debris

Removal of hazardous materials and debris from within the NPR-A would likely involve transport of equipment and personnel and removal of hazardous materials or debris. Some coastal and most inland sites would likely be active during the winter and should have no impact to belugas, harbor porpoises, or killer whales. Some sites near the coast could involve shipping and barging during the open-water season in summer and autumn. Thus, noise from vessels and aircraft could affect any of these cetaceans.

Beluga whales can respond dramatically to ships and icebreakers. Below (see Shipping/Barging/Aircraft) is a more detailed discussion about information related to the response of belugas to vessels at sea. For cleanup activities, belugas, narwhals, harbor porpoises, and killer whales may be excluded from specific areas during the duration of cleanup, possibly lasting for weeks or months during one or two open-water seasons.

Ice Seals

Aircraft and vessel traffic are the non-oil and gas activities most likely to have a direct impact on any seal species. Little if any impact is expected to occur to ribbon seals because they rarely occur in the nearshore environment.

Spotted seals hauled out on land in summer are unusually sensitive to aircraft overflights compared to other species. They often rush into the water when aircraft fly at altitudes as high as 984 to 2,461 feet (300 to 750 meters). They occasionally react to aircraft flying as high as 4,495 feet (1,370 meters) and at lateral distances as far as 1.2 miles (2 kilometers) or more (Frost and Lowry 1990, Rugh et al. 1997). Currently, the National Marine Fisheries Service's threshold for determining if an aircraft overflight may take a marine mammal or not is 1,000 feet (approximately 300 meters) altitude (except for takeoffs, landings, and emergency situations). Little information is available on the reaction of seals in water to overflying aircraft, although it appears that spotted seals in the water are much less sensitive to aircraft (R. Suydam, North Slope Borough, personal observations, Richardson et al. 1995). During the open-water season, the 2011 Bowhead Whale Aerial Survey Project and Chukchi Sea Offshore Monitoring in Drilling Area surveys reported only 6 percent of unidentified pinnipeds reacted to overflights at an altitude of 1,530 feet (466 meters; National Marine Fisheries Service unpublished data). Typical reactions included diving or a change in swimming direction.

Non-oil and gas-related vessel traffic authorized by this alternative within the NPR-A region would primarily be associated with survey and research activities. The reaction of seals to vessel traffic can be highly variable ranging from no change in behavior to direct avoidance, depending on species and location (Jansen et al. 2010, Smiley and Milne 1979, Mansfield 1983, Calambokidis et al. 1983.) When industry monitoring ships traveled under non-seismic conditions, the average closest point of approach to seals in the water ranged from 160 to 180 meters (525 to 590 feet; Haley et al. 2010, Savarese et al. 2010). Seismic source vessels traveling under non-seismic conditions appear to disturb seals at greater distances, perhaps in part because of their larger size, with the average closest point of approach to seals in the water ranging from 200 to 400 meters (556 to 1,312 feet; Haley et al. 2010, Savarese et al. 2010). These averages, however, are derived from observations that span a wide range of distances for initial seal detection, which is dependent upon several factors including weather, sea conditions, and vessel height.

Spotted seals hauled out on ice can often be approached to within 100–200 meters by a slow-moving small boat without flushing animals into the water as long as ice is present between the boat and the animals (J. Herreman, North Slope Borough, personal observation). This distance may increase dramatically when ice is not present, and seals are hauled out on terrestrial substrate, if spotted seals react similarly to harbor (*Phoca vitulina*), ringed, and bearded seals. Suryan and Harvey (1999) found harbor seals reacted to boat traffic within 1 kilometer of haulouts, particularly kayakers. During open-water surveys in the Beaufort and Chukchi seas (Harris et al. 2001, Blees et al. 2010, and Funk et al. 2010) ringed and bearded seals showed slight aversions to vessel activity. Funk et al. (2010) noted among vessels operating in the Chukchi Sea where received sound levels were less than 120 decibels, 40 percent of observed seals showed no response to a vessel's presence, slightly more than 40 percent swam away from the vessel, 5 percent swam toward the vessel, and the movements of 13 percent of the seals were unidentifiable. In the concurrent set of surveys conducted in the Beaufort Sea where sound levels were less than 120 decibels, approximately 30 percent of observed seals showed no reaction to vessel activity, 50 percent looked at the vessel, and 10 percent splashed in the water.

Vessel traffic will likely have little effect on seal populations except in relation to terrestrial spotted seal haulouts. As a general statement, the potential exists for population-level effects near spotted seal haulouts associated with concentrated vessel traffic and repeated disturbances. Increased vigilance of animals and decreased haulout time due to disturbance could lead to a decrease in body condition of some individuals (Brasseur et al. 1996). Decreased body condition of a significant number of breeding females could lead to population declines through lower reproductive and survival rates of pups. Decreased body condition in the population as a whole, could also lead to a decrease in overall survival.

Small fuel spills may occur in conjunction with research and inventory projects, recreation, subsistence activities, and other non-oil and gas activities. These spills would most likely involve light-fraction hydrocarbon fuels such as unleaded gasoline and aviation fuel. These fuels would evaporate and disperse rapidly and would be cleaned up immediately whenever possible as required by permit and lease stipulations. These small spills are expected to have a negligible impact on ice seals.

Ground-based activities (such as resource inventories, site cleanup, and recreation) and remote camps also create potential disturbance for ice seals. This possibility of disturbance is highest under two scenarios: (1) near terrestrial haulouts during the ice-free season and (2) in the shore fast ice region, particularly during spring. Most of these activities would likely take place during the ice-free season, and as such, as long as terrestrial haulouts are avoided, possible disturbance will be minimized.

Under Alternative A, the effects of non-oil and gas activities on ribbon seals would be negligible and inconsequential at the population-level because these seals spend little time in the nearshore environment and are rarely known to haul out onshore or in the landfast ice region. Effects to spotted seals could occur, but would be largely avoided if terrestrial haulouts are avoided. Most major spotted seal haulouts are along the Chukchi coast including the Kasegaluk Lagoon Special Area, which was specifically created "primarily because of high values for marine mammals," and will receive "maximum protection" consistent with exploration of the Reserve. Spotted seals hauled out on land are particularly sensitive to vessel and aircraft disturbances, the reactions to which are described above. Repeated disturbance could impact life history functions, such as resting, feeding, and pupping, resulting in potential decreased individual or—if aggregations of seals are repeatedly disturbed—localized population-level fitness and survival.

4.3.10.2 Oil and Gas Exploration and Development Activities

Baleen Whales

Aircraft

Most aircraft flights would originate from Prudhoe Bay/Deadhorse or the Alpine air field. Some may originate from the Barrow airport. Most flights to support exploration occur during winter months; summer flights to support exploration typically are conducted in mid-July and are related to equipment maintenance over a period of 10–14 days (USDOI BLM 2004). Limited information exists on the effects of aircraft on marine mammals in the Arctic.

Aircraft flying at altitudes greater than 1,000 feet (303 meters) generally do not affect gray whales, and are unlikely to affect minke whales (Richardson and Malme 1993). Flights supporting oil and gas operations in the NPR-A could overlap gray whale nearshore feeding areas such as near Barrow and occasionally Cape Simpson. Little information exists on long-term effects; however, effects of aircraft traffic on gray whale behavior would likely be localized and short-term and not likely to impact health or survival at the individual or population levels.

Under Alternative A, aircraft associated with development may occasionally occur over waters occupied by gray whales, such as supply flights between Cape Simpson, Barrow, and Prudhoe Bay. However, given the terrestrial location of the two major airports of origin (Barrow and Prudhoe Bay), effects to gray and minke whales are expected to be limited.

Seismic Activities

Onshore seismic surveys would not be expected to have any impacts on gray or minke whales, because none of the marine mammals occur in the Beaufort or Chukchi seas during the winter when seismic would most likely occur. Moreover, a thick permafrost layer would likely prevent onshore seismic noise from being conducted into the marine environment.

Small areas off-shore near Atigaru Point and Elson Lagoon may have some seismic activity. It is expected that any seismic activity would be done over ice; however, that may not always be the case. Impacts on minke whales are unlikely, since they are not known to frequent that area. Impacts on gray whales depend on the timing of seismic activities and whether they coincide with gray whale presence in the area. Gray whales are seen east northeast of Point Barrow, but rarely close to shore. Some research has shown that airguns can interrupt feeding behavior in gray whales. Malme et al. (1986) studied the responses of feeding gray whales to pulses from a single 100 in^3 airgun off St. Lawrence Island in the northern Bering Sea. They found that about half of the whales stopped feeding at higher sound levels, but that decreased to only 10 percent disrupted at lower sound levels. Studies in Russia and British Columbia showed no apparent change in feeding patterns resulting from seismic surveys (Yazvenko et al. 2007, Bain and Williams 2006). Although some individual gray whales may be temporarily disturbed by seismic activities, impacts to individual or population-level health and survival are unlikely.

Shipping

Moore and Clarke (2002) summarized various studies and concluded that gray whales will show responses to a variety of man-made noise including shipping. They reported, disturbed whales usually changed their “swimming course to avoid the [noise] source.”

Noise-producing marine vessel and aircraft traffic would be the most probable source of disturbance to non-special status whales under this alternative. These whales could encounter a few vessels associated with oil and gas activities in the planning area during summer feeding, mainly in the Chukchi Sea. Although most of the vessel activity would be in shallow nearshore waters from Harrison Bay to the Kuk River near Wainwright, these waters are, at times, traversed by feeding gray whales (Tracey 2002, Clarke et al. 2011). Studies to date suggest that ship collisions with gray whales are uncommon. Hunters have not reported “skittish” behaviors for gray whales associated with shipping, though gray whales have been observed to avoid noise and offshore oil and gas development (Weller et al. 2002). Gray whales are regularly exposed to vessels and vessel noise in their wintering ground and throughout most of their spring and fall migrations, however, their numbers have recovered to a level approaching what has been estimated as pre-commercial harvest era levels.

Most boat traffic associated with exploration and development within the planning area is expected to be either multi-vessel sealifts to support construction or a single transport vessel for annual resupply or transport of equipment. Some small vessel traffic may also occur for oil spill response practice.

Sealifts and regular support shipping typically take place in late July through September to take advantage of the reduced ice and to avoid conflict with subsistence whaling. Sealifts to support construction would likely come ashore along the northern coast of the NPR-A, and material would be stored at a staging area (e.g., Lonely, Cape Simpson, Barrow, and Wainwright) until ice roads could be constructed and the material then would be moved overland to the construction site.

After initial construction, barges may also be used to resupply oil and gas developments. Much of that material may come ashore at the Prudhoe area where facilities for storage exist and be transported overland or by air, with only heavier equipment landed in the NPR-A.

Marine mammals that occur in or adjacent to the planning area may react and maneuver to avoid boats. However, the distance at which they react is dependent on the species, individual, activity/season, type size and behavior of boat, and physical conditions (review in Richardson et al. 1995; Moore and Clarke 2002). The duration and severity of the avoidance behavior may vary considerably, with some evidence that whales actively avoid shipping lanes and other reports of possible habituation (Moore and Clarke 2002).

Vessel traffic associated with exploration and development may encounter multiple individuals of several species of marine mammals. Encounter times would be relatively short, and individuals would likely encounter the vessel once in any period, possibly twice as vessels would be traveling point to point, unlike survey ships or seismic vessels. Shipping activity would take place after calving/birthing periods and when animals are typically well distributed foraging, or possibly during the beginning of early fall migration. Gray whales are expected to have short-term, short distance avoidance behaviors, which may reduce feeding opportunities, but are not expected to result in abandonment of foraging areas, or measurable declines in body condition as a result (Richardson et al. 1995).

While bowheads show strong reactions to shipping and other man-made noise, gray and possibly minke whales show lesser reactions (Moore and Clarke 2002). Given the short duration and limited number of disturbance events resulting from development in the planning area, the effects are not expected to result in reduced reproductive rates, and direct mortality would likely be rare for gray and minke whales.

Minke whales are susceptible to ship strikes in other seas, but because this species occurs infrequently in NPR-A coastal waters, effects from ship strikes are expected to be very limited.

Gray whales can be relatively abundant in the nearshore NPR-A Chukchi and western Beaufort sea waters in certain areas and years (Clarke et al. 2011a, Clark et al. 2011b). Because of this, ship collisions are possible, but documented incidents for this species are quite rare, and therefore, expected to be limited (Allen and Angliss 2010).

Contaminant Spills

A detailed discussion of the potential effects of oil on whales can be found in the Beaufort Sea Planning Area Oil and Gas Lease Sale 186, 195, and 202: Final EIS (USDOI Minerals Management Service 2003d), pages IV-73-IV -77. This document and the subsequent Biological Evaluation for the Chukchi and Beaufort Sea OCS Leases

(USDOI Minerals Management Service 2006f) document the effects of oil on bowhead and the difficulty in applying information to other species. The Minerals Management Service (2003d) suggests that oil may act on bowhead whales through oiling the skin, inhalation, ingestion, baleen fouling, reduced prey and displacement from feeding areas, and death. In examining the available information, the Minerals Management Service found that support for and against such effects occurring were equivocal. The Minerals Management Service concluded in their Biological Evaluation that most adult whales exposed to spilled oil would suffer temporary or permanent non-lethal effects, but that prolonged exposure to freshly spilled oil could result in death (USDOI Minerals Management Service 2006f, p 87). Impacts to newborn and very young calves may be greater. Albert (1981) speculated a number of sub-lethal effects from oil contact to bowheads including exacerbation of normal skin lesions, compromising of tactile hairs, obstruction of the "connecting channel" of the stomach, irritation of the eye, and other effects. Similar types of effects could occur to gray and minke whales.

Spill containment and cleanup, if they were to occur outside of the nearshore habitat during the autumn migration, may affect whales by causing deflection and avoidance of the area. Any offshore displacement effect, however, is likely outweighed by the reduced potential to come in contact with spilled oil.

An oil spill resulting from development under Alternative A would be unlikely to occur in the marine environment, or to reach typical bowhead whale migration habitat from onshore locations. Small spills would be unlikely to reach marine habitats, and thus, would have a low probability of affecting gray and minke whales.

Effects of a Fuel Spill Associated with Barging

It is possible that a contaminant spill could result from barge traffic (i.e., a sinking or holing of the tug or fuel tank(s) of a self-propelled barge). To date there is no record of such spills associated with barging in support of oil and gas development and exploration, and such a spill is considered highly unlikely. However, a spill associated with Navy supply operations did occur in NPR-A waters in 1944. Thomas Brower, Sr., described a 25,000-gallon (595-barrel) oil spill in Elson Lagoon along the Plover Islands in 1944 (Brower 1980). He noted that it took approximately 4 years for the oil to disappear and that, during that time, bowhead whales that normally migrate close to the islands made a wide detour out to sea during fall migration when passing near Elson Lagoon/Plover Islands (Brower 1980). This suggests that, at least in the case of bowhead whales, displacement can last for several years and that bowhead whales may be able to detect an oil spill and avoid surfacing in it by detouring around the area of the spill (Minerals Management Service 2008). Whether other baleen whale species in the region would react similarly is not known.

Summer storms are a concern. A North Slope Borough dredge barge was sunk in a powerful storm off Barrow in August 2000. Also, in the 1960s, a powerful storm drove at least three fuel barges ashore on Tapkaluk, Martin, and Igalik Island east of Barrow. At least two barges still remain on Martin Island. It is not clear how much, if any, fuel was spilled. However, if a spill occurred in this area, there is a likelihood of affecting marine mammals. A spill that occurred in summer or fall during the shipping season could affect any marine mammal species that occurs in the Beaufort or Chukchi waters adjacent to the NPR-A. Such a spill may result in lethal or sublethal effects on gray whales. The actual number of animals affected would be dependent on the volume of spill, the weather, and the success of cleanup efforts. Impacts to minke whales are less likely since they are infrequent visitors to these waters.

Vessel Collisions

Vessels may strike and injure or kill marine mammals (Laist et al. 2001), and are the main source of anthropogenic mortality preventing the North Atlantic right whale from recovering (Kraus 1990). Direct collisions have resulted in mortality and injury to whale species. Contact with the propeller(s) and direct collisions are known to injure bowhead whales and other large marine mammals (George et al. 1994; review in Laist et al. 2001).

Based on behavior and habitat use, it is more likely that whale species would be struck than seal species, and that larger, slower, or less reactive species would have greater potential to be struck. While all sizes of vessels have been involved in collisions with whales, vessel size and speed are factors in determining whether a collision results in severe injury or death. Ships over 260 feet long are more likely to cause severe injury or death than are smaller vessels (Laist et al. 2001). Total length of barge or tow vessel may be greater than 260 feet, but it is not known if they are equally likely as a self-contained vessel to cause severe injury in a collision.

Any increase in shipping traffic related to development in the NPR-A could increase the potential for collisions with gray and minke whales. Alternative A could result in significant periodic barge traffic over approximately 50 years, in addition to the existing levels of shipping to support other development in Prudhoe Bay and North Slope villages. North Slope barge traffic is typically much slower than 14 knots, while most collisions causing severe injury or mortality occur when ships are traveling faster than 14 knots (approximately16 mph) (Laist et al. 2001) and drops markedly below 11.8 knots (Reeves et al. 2012). Some evidence is provided by Laist et al. (2001) that the number of whale strikes has increased as the number of ships increased worldwide, suggesting that an increase in shipping traffic could result in increased strikes (Laist et al. 2001).

Development and Production

Presumably, once production is under way within the NPR-A, shipping and barge activity would decrease, and thus, impacts would be reduced. However, to the extent that development in the NPR-A is not linked by a road to the Dalton Highway, barging will remain the main mode of transportation for resupply and oil field equipment. Throughout most of the NPR-A coastal waters, shipping and barging would be the prevalent activity associated with development and production that could impact baleen whales. The potential effects of vessel disturbance or collision are discussed above.

Noise generated during possible development adjacent to known gray whale feeding areas in the northeast Chukchi Sea, such as the vicinity of Peard Bay, could result in short-term disturbance or displacement of gray whales.

Toothed Whales

Seismic Activities

There are few studies available regarding the effects of seismic activity on wild belugas. Studies of captive beluga whales reveal changes in behavior when exposed to strong, pulsed sounds similar in duration to those used in seismic surveys (Finneran et al. 2002), but the received sound levels were relatively high before aversive behaviors were observed (peak to peak level >200 dB re 1 µPa). Behaviors such as vocalizing after the exposure and reluctance to station at the test site were observed (Finneran et al. 2002). Similar behaviors were observed by a beluga whale exposed to a single underwater pulse similar to those produced by distant underwater explosions (Finneran et al. 2000). The applicability of these observations in trained, captive beluga whales exposed to a single transient sound to the natural environment of free-ranging animals exposed to multiple pulses over time, is unknown. One study suggested that belugas may avoid seismic vessels at great distances. Miller et al. (2005) conducted aerial surveys during seismic operations in the southeastern Beaufort Sea where they recorded much lower sighting rates of belugas within 6 to 12 miles (10–20 kilometers) of an active seismic vessel. Observers on-board the source vessel saw few belugas. They, thus, concluded that some belugas might be avoiding the seismic operations at distances of 10 to 20 kilometers (Miller et al. 2005).

Porpoises show variable and species-specific reactions to seismic operations. The limited data available suggest harbor porpoises show stronger avoidance of seismic air guns than Dall's porpoises (Stone 2003, Bain and Williams 2006). Harbor porpoises in Washington State waters, appeared to be the species affected by the lowest received level of air gun sound (less than 145 decibels re 1µP rms at a distance greater than 70 kilometers [43.5 miles]) despite primarily communicating with high frequencies (Bain and Williams 2006). Similarly, during seismic surveys in the late 1990s with large air gun arrays off the United Kingdom, there were significant differences in directions of travel by harbor porpoises during periods when the air guns were shooting versus silent (Stone 2003, Stone and Tasker 2006), suggesting displacement and disturbance.

Stone and Tasker (2006) found that, although sighting rates did not decrease in the presence of operating airguns, killer whales showed some spatial avoidance by remaining farther from the source when it was active.

Seismic surveys in coastal or deeper marine waters typically involve air gun arrays. Air guns create a large amount of broadband sound that could cause deflection or even hearing damage in marine mammals. Onshore and sometimes nearshore on-ice seismic surveys more typically involve vibroseis, but mostly during ice-covered months when whales and porpoises are absent. Seismic surveys in Dease Inlet, Admiralty Bay, and Elson Lagoon would generally be prohibited from 15 May to 15 October, although this stipulation could be waived. If seismic surveys occur during the summer within those areas or in Peard Bay or Kasegaluk Lagoon (after 2014), there could be impacts to any of these toothed whales from noise produced by air guns or vessels. The most vulnerable location for belugas would be along Kasegaluk Lagoon, where the eastern Chukchi Sea stock of belugas aggregates in late June and early July. Belugas might deflect away from seismic surveys by 10 to 20 kilometers or more. This could reduce feeding opportunities. Stress levels could increase. The ability of animals to communicate with one another could also diminish. Masking of sounds could result in additional stress or disturbance to belugas. If disturbance was high enough, there could be an increased possibility that cows and calves could be separated. Impacts might be similar for harbor porpoises and killer whales, although they do not aggregate in coastal areas, therefore, impacts would likely involve fewer animals. Narwhals might be impacted, as well, although their occurrence in the area is sufficiently rare that impacts are unlikely.

Exploratory Drilling

Exploratory drilling within the NPR-A would mostly occur in onshore areas during snow- and ice-covered months, when toothed whales are absent. Shipping and barging support of exploratory drilling within the NPR-A could occur during open-water months when belugas and other toothed whales are present. Potential impacts from shipping and barging are discussed below. There would be no impacts from sounds from exploratory drilling if that activity is confined to the onshore areas and during winter months and no oil spill or discharges occur that end up in the Chukchi and Beaufort seas. There could be impacts from exploratory drilling if there was a blowout or discharges from drilling entered the marine environment and were not cleaned up before the open-water season.

Drilling activities in nearshore marine waters of Kasegaluk Lagoon (after 2014), Peard Bay, Dease Inlet, or Smith Bay could generate noise that affects localized distributions of toothed whales. Drilling sounds have been shown to disturb belugas. Similar studies are not available for the other species of concern in this section. Belugas were observed to change course when they came within 0.6 mile (1 kilometer) of a drillship and exhibited aversive behavior when support vessels were operating near the drillship (Richardson et al. 1995). Reactions of belugas (captive and wild) to playbacks of the semisubmersible drillship SEDCO 708 indicate that belugas exhibit slight avoidance reactions to drillship sounds (Richardson et al. 1995). Furthermore, belugas may not be able to detect the lower frequency sounds of drillships, which usually emit sounds below 1 kHz, because they are below their best hearing sensitivity. Harbor porpoise hear at higher frequencies than belugas (Southall et al. 2007), so are even less likely to detect the sounds in the lower frequency ranges. Effects would likely not occur because exploratory drilling within NPR-A would likely not occur from a drillship. Most exploratory drilling would occur in the winter and on land.

Shipping, Barging, and Aircraft

Shipping, barging, and aircraft could impact toothed whales primarily through noise disturbance. Those impacts could cause animals to be deflected or anthropogenic sounds could mask the ability of whales and porpoises to communicate with one another. Ship strikes and discharges could occur. Some stocks of belugas, porpoises, and killer whales occur in areas with considerable boat traffic (such as Cook Inlet or Bristol Bay). Animals in those areas appear to be somewhat habituated to the presence and sounds from ships. Belugas and other toothed whales that primarily live in habitats with lower levels of boat traffic (i.e., the Beaufort and Chukchi seas, high Canadian Arctic) may be more sensitive to anthropogenic sounds from ships.

There have been few studies on how toothed whales respond to ships and barges in the Beaufort and Chukchi seas or other areas of the Arctic. Beluga detection of vessel noise below 5 kHz appears to be limited by their hearing threshold and they are apparently unable to detect low frequencies beyond a few hundred meters from the source (Cosens and Dueck 1993). Belugas, particularly in areas where they are subject to subsistence harvests, have an aversion to outboard powered boat traffic (Huntington et al. 1999). They may habituate to constant noises, but avoid variable anthropogenic noise (e.g., boats, helicopters) (Huntington et al. 1999). Lesage et al. (1999) found that exposure to vessel sounds caused belugas to change their call type and frequency (Lesage et al. 1999). Alaska Native beluga whale hunters with the Cook Inlet Marine Mammal Commission note that Cook Inlet beluga whales are very sensitive to boat noise, and will leave areas of high vessel use. In contrast, beluga whales appear relatively tolerant of intensive fishing vessel traffic in Bristol Bay and are commonly seen during summer at the Port of Anchorage (Norman 2011). Despite few data, there is an indication that belugas can react strongly to ships at large distances. Increasing shipping in the Arctic could negatively influence the distribution and behavior of belugas, and possibly porpoises and killer whales. Vessel traffic to and from NPR-A would likely be relatively small, but could contribute to impacts on belugas.

Section 4.3.10.1 ("Activities Not Associated with Oil and Gas Exploration and Development") provides a discussion about impacts of aircraft on belugas. The same types of impacts would apply here.

Increasingly, there is a concern that anthropogenic sounds could mask the ability of marine mammals to communicate with one another or be fully aware of the surrounding environment (Jensen et al. 2009; Clark et al. 2009). Increased oil and gas activities associated with the NPR-A would increase the level of anthropogenic sounds in the Arctic Ocean and contribute to possible masking of marine mammal sounds. Erbe and Farmer (1998) reported that the Canadian Coast Guard icebreaker, while breaking ice, masked recordings of beluga vocalizations at a signal-to-noise ratio of 18 decibels. They (Erbe and Farmer 2000) used a propagation model to predict that icebreaker noise could mask beluga whale communication within 14 to 71 kilometers (8.7 to 44.1 miles) of the vessel. There are no other studies in the Arctic about how beluga sounds might be masked by anthropogenic sounds from vessels. The available data suggests that ships operating in the Beaufort and Chukchi seas could hinder belugas' ability to communicate. Holt et al. (2011) found that killer whales in British Columbia increased their call amplitude to compensate for increasing noise levels and vessel masking. By extension, masking could also impact porpoises and narwhals.

Toothed whales could be struck by vessels, potentially causing injury or death. There are few data on the incidence of ship strikes of these animals in the Beaufort and Chukchi seas. Therefore, it is not clear whether this is a problem, and the chance of obtaining data on ship strikes is limited. If a beluga or other toothed whale was struck and killed by a vessel, the carcass would likely sink (because blubber is relatively thin, toothed whales usually sink immediately after death) although it may float to the surface several days after death as gases accumulate. Carcasses likely do not remain at the surface very long, as gulls and other animals scavenge on the carcass, which then sinks again. If an animal is struck near shore, it could be cast on the beach but may not be noticed because of the remoteness of most beaches in the Arctic. If an animal was struck offshore, it seems unlikely that it would be noticed.

Even though there are few data on whether ship strikes are a concern for toothed whales, there are some measures that could be taken to reduce the possibility of collisions. It is likely that the frequency and severity of ship strikes with marine mammals are influenced by vessel speed. The potential for collision with marine mammals in general increases at speeds of 15 knots and greater (Laist et al. 2001, Vanderlaan and Taggart 2007). Most seismic source vessel speeds are relatively slow (approximately 3 to 5 knots) during oil and gas exploration activities. Transit speeds, however, are likely to be much higher. Seismic survey source vessel transit speeds are, for example, estimated at 8 to 20 knots, suggesting that, if collisions were to occur, they are more likely when vessels are in transit. Increasing vessel traffic in the Beaufort and Chukchi seas could increase the possibility of collisions.

Development and Production

Development and production of oil and gas contribute sounds to the environment. Most of the potential oil and gas production within the NPR-A would be on land, thus, relatively few sounds, if any, would be added to the marine environment where they might impact belugas, porpoises, killer whales, or, on a rare occasion, narwhals. Aircraft (as described above) supporting a facility could impact belugas. In general, however, the sounds from development and production within the NPR-A would probably not disturb Arctic toothed whales.

Development or production in nearshore marine waters of Kasegaluk Lagoon (after 2014), Peard Bay, Dease Inlet, or Smith Bay could generate noise that affects localized distributions of toothed whales, particularly beluga whales migrating along the Chukchi coast during the spring or congregating in Kasegaluk Lagoon in early summer. This could result in short-term disturbance, avoidance, or displacement.

Oil Spills and Contamination

Because most oil and gas activities within the NPR-A are away from the coast and development is set back from major rivers and most of the NPR-A coastline, there is a limited chance that spilled oil would reach the ocean where it might impact marine mammals. If a large oil spill occurs near a major river drainage, coastal area, or in a pipeline that crosses the NPR-A, the chances are greater that spilled oil will reach the marine environment. Although a large spill may occur under this alternative and it is possible it could reach areas used by toothed whales, it is improbable.

If a large spill reached the marine environment, the potential impacts to belugas would be greatest along the Chukchi Sea coast. Some beluga whales have been seen offshore of the Beaufort Sea coast but most occur considerably farther offshore, feeding along the continental shelf break, thus further reducing the possibility of exposure to belugas of spilled oil. Harbor porpoises have been seen near shore, including in Elson Lagoon and Peard Bay (Suydam and George1992,), therefore, they could be impacted by spilled oil if an event occurred. Killer whales have also been seen near shore and in Peard Bay (George and Suydam 1998) but probably are offshore more frequently. Offshore animals are likely less susceptible to an oil spill that are those that frequent coastal areas. Narwhals are extremely rare in the area, so are unlikely to be impacted by an oil spill in the NPR-A.

Small onshore spills would generally not have any effects on marine mammals, unless the spills entered and contaminated streams that run into the Beaufort and Chukchi seas. Although small spills are expected to happen under this alternative, the anticipated spill volume is sufficiently low that it is unlikely that oil would reach waters used by toothed whales.

It is possible that a spill could result from barge traffic. A barge or tug could sink, or a hole could develop in a fuel tank. If a spill such as this were to occur, there is a greater chance that it might affect belugas or other marine mammals. This type of spill would most likely occur during the open-water period from July through October when vessel traffic is highest.

If toothed whales were exposed to spilled oil, petroleum products, or other hazardous discharges in marine habitats, they might suffer lethal or sublethal effects from direct exposure or inhalation of fumes. They might also ingest the oil if their prey were to become contaminated. Exposure or ingestion of oil or petroleum products would likely negatively impact the health, survival, or reproductive potential of animals. The actual number of animals affected, and thus, the chances of impacts to the populations, would be dependent on the numbers of animals in an area, spill volume, timing, weather, and the success of cleanup efforts.

Ice Seals

Seismic Activities

Onshore seismic surveys are not expected to impact seal species because the seals are not present at that time or location.

Disturbance from off-shore seismic surveys, including shallow hazard/site clearance surveys that commonly use air gun arrays, on-ice vibroseis surveys, and ocean-bottom cable surveys are of concern. Seismic surveys using large towed marine-streamer air gun arrays typically occur in deeper offshore waters and would not likely be used for NPR-A exploratory activities. On-ice surveys (vibroseis) are typically conducted during winter in the shallower, nearshore waters on thickened sea ice capable of supporting the equipment. These areas are unlikely to be occupied by spotted or ribbon seals during this time (see section 3.3.7 in Volume 1).

Marine seismic surveys, employing airgun arrays, may occur during open water in nearshore zones. For the purposes of calculating "take by harassment" under the Marine Mammal Protection Act, National Marine Fisheries Service considers any marine mammals exposed to pulsed sound levels at or above 160 decibels to experience potential Level B behavioral harassment. Seals, however, have been noted to tolerate high levels of sounds from air guns (Moulton and Lawson 2002). As per Required Operating Procedure C-1, operators will consult with National Marine Fisheries Service prior to seismic operation and equipment movement. Seals are unlikely to be greatly disturbed by source sounds from an ocean-bottom cable operation.

Based on what visual observers can detect, seals often do not react strongly to passing seismic ships. Seals show little variance in the distance they stay from seismic ships due to active or inactive arrays (Haley et al. 2010, Savarese et al. 2010). The observable behavior of seals to passing active source vessels is often to watch vessels pass by or to swim in a neutral way relative to the ship. Seals at the surface of the water would experience less powerful sounds than if they were the same distance away but in the water below the seismic source. This may account for the apparent lack of strong reactions in ice seals to ship-based seismic surveys.

In addition to air guns, site clearance and high-resolution shallow hazards surveys utilize smaller, higher frequency sound sources for bottom profiling. Very few data are available on the reactions of seals to echosounder sounds or other devices at frequencies similar to those used during seismic operations; however, because most of their hearing is in the low-frequency spectrum, HF or VHF frequencies are likely inaudible to them. Hastie and Janik (2007) found that captive gray seals reacted to underwater multibeam echosounder signals by significantly increasing their dive times. However, because sound exposure is brief, reactions are anticipated to be limited to startle or otherwise brief responses of no lasting consequence to the animals.

Few data exist regarding sound levels and durations needed to cause temporary threshold shift in seals. Temporary threshold shift is the mildest form of hearing impairment that may occur during exposure to loud sound (Kryter 1985). Although not considered physical injury, since hearing sensitivity recovers soon after the noise stops, it is an indicator that physical injury is possible if the animal is exposed to higher sound levels. Temporary threshold shift was measured during controlled studies on harbor seals, California sea lions, and northern elephant seals; only one study examined temporary threshold shift in response to exposure to underwater pulses (Finneran et al. 2003). No data are available for any free ranging marine mammals or for exposure to multiple pulses of sound during seismic surveys.

The effect of seismic activities on the long-term hearing of phocids has not been definitively studied. The potential for damage (permanent threshold shift) exists if a seal is exposed to sound exposure levels (SELs) greater than 185 decibels re: 1 μPa2-s or sound pressure levels (SPLs) greater than 218 decibels re: 1 μPa (peak), however, typically these noise levels only radiate out a few 10s of meters from firing air gun arrays (Bureau of Ocean Energy Management 2010 [2010-020], 2011 [2011-036], Southall et al. 2007). Seals could avoid the sound by leaving the area or remaining at the surface with their heads out of the water. A seal is not likely to remain close enough to a large airgun array or other loud sounds source long enough to incur hearing damage or other physical effects of noise. The received levels of successive pulses would increase and then decrease gradually as the seismic vessel approaches, passes, and moves away. Seals with their heads out of the water, or hauled out would be exposed to greatly reduced levels of sound, further decreasing potential harmful effects of underwater seismic sound. In addition, the seasonal distribution of ribbon and spotted seals makes it unlikely that either species will be in the area of the NPR-A during most seismic activity.

Prey of ice seals (various fish, shrimp, crustaceans, benthic invertebrates, amphipods, krill: see section 3.3.7.1) may be affected by marine seismic surveys. The effects of seismic surveys on fish are described in section 4.3.7.2. Adult fish are most likely to temporarily flee loud sound sources, although egg and larvae may be vulnerable to loud sound sources at close range. Studies of the impacts of vibroseis on fish indicate that avoidance behavior is the most likely reaction; there was no indication of physical injury or mortality. Multiple exposures, however, could be of concern. Given the diversity of prey consumed, and the wide distribution and dynamic nature of prey fields for ice seals, it is unlikely that seals would experience any lasting changes to their foraging success as a result of seismic surveys.

Development and Production

Drilling and production operations involve establishing drilling and production platforms and deploying numerous support vessels or vehicles. Onshore drilling and production is unlikely to have direct negative impacts upon ice seals due to the lack of seals onshore. Offshore drilling and production, however, are of concern. The level of disturbance to seals is likely more intense in terms of the physical presence of the platforms compared to other types of actions, but the geographic area involved is much smaller. The noise generated from drilling is also not as loud as seismic air guns, but it is produced on an almost continual basis, making it more of a chronic sound source in one location. There is little documentation on the reaction of ribbon or spotted seals to drilling and production activities at drill sites. Drilling activities could deter seals from venturing close to operation platforms. Given the mild reaction of seals to marine vessels, with the exception of spotted seals on terrestrial haulouts, this area of displacement would cover a very small area. Adverse effects are unlikely to occur for ribbon seals due to their offshore distribution and are only likely to occur for spotted seals if such operations take place near a terrestrial haulout during the open-water season.

Under Alternative A, leasing would be deferred in the western NPR-A 2014 deferred leasing area (including much of Kasegaluk Lagoon and Peard Bay) and from areas northeast of Teshekpuk Lake in the deferred leasing area until 2018. After 2014 and 2018, respectively, however, the above noted effects could occur to spotted seals in these areas. After 2014, the Kasegaluk Lagoon Special Area would be managed to receive maximum protection for marine mammal values, consistent with exploration of the Reserve. Stipulation K-8b would help enforce this goal, as it would prohibit permanent oil and gas facilities within the boundary of the Special Area after the deferral is lifted. This would preclude most or all chronic sound sources from originating within Kasegaluk Lagoon, and protect spotted seal haulouts in that area. In Alternative A, Stipulation K-3b reduces potential chronic sound effects to spotted seal haulouts in Dease Inlet, Admiralty Bay, Elson Lagoon and associated islands by prohibiting exploration activities from May 15 through October 15,and by prohibiting most permanent facilities within three-quarter mile seaward of the shore. Stipulation K-6 extends protections to the inland side of the coastline by prohibiting, under most circumstances, permanent oil and gas facilities within three-quarter mile. A notable exclusion to this is the 2014 deferral area. All combined, these stipulations will help protect seals from disturbance at many spotted seal haulouts, but may leave some haulouts unprotected, such as those in Peard Bay and on the ocean side of barrier islands. They also do not necessarily protect against indirect effects such as loss of prey base.

Any development and production activity that negatively impacts fish habitat or survival could have detrimental effects on both ribbon and spotted seals, as fish are the primary prey items of these species. Spotted seals are most likely to be negatively impacted by activities that decrease nearshore and river fish species, while ribbon seals would be impacted by changes in pelagic species. For possible effects to fish species from development and production operations, see section 4.3.7.

Travel and Shipping

Seals show little negative response to vessel traffic in open water conditions with the exception of traffic close to terrestrial seal haulouts. As such, marine traffic is unlikely to have adverse effects on spotted and ribbon seals as long as terrestrial haulouts are avoided. Air traffic would have similar effects as those listed in the non-oil and gas-related section above. The major difference is the possibility of increased point traffic travel to production and drill facilities, which would lead to an increased chance of disturbance. Travel during the shorefast ice season would have little effect on spotted and ribbon seals, as they are highly unlikely to be present in the NPR-A management area during that time.

Contaminant Spills and Discharge

Small contaminant spills are unlikely to have significant detrimental impacts to ribbon or spotted seals as described above in the non-oil and gas-related activities section, with the exception that numerous small spills over time could have an impact if a small number of animals were to come in contact with each spill. A larger contaminant spills that enters a major waterbody, however, could have detrimental effects to spotted seals and possibly ribbon seals. Spotted seals are known to range large distances up coastal riverways (Braund 2010, Boveng et al. 2009) and spend most of the summer in nearshore coastal waters. Spotted seals therefore could potentially come into contact with any large contaminant spill (i.e., crude oil or other production-related products) that enters a waterbody connected to the marine environment, although more seals may be at risk if marine waters are directly contaminated.

The potential for an onshore spill of any size to reach marine or marine-connected waters is minimized by stipulations K-1 and K-6. K-1 names 24 rivers where permanent oil and gas facilities such as well pads must be set back, at minimum, one-half mile from the banks. K-6 prohibits the same type of facilities from being placed within three-quarters of a mile (inland) of the NPR-A coastline.

The potential for a spill to occur directly into the marine environment is reduced by the leasing deferrals (while they are in place), as well as Stipulations K-3b and K-8b. After the western deferral is lifted from the Kasegaluk Lagoon area, the K-8b stipulation would prohibit permanent oil and gas facilities there (such as wellheads). Stipulation K-3b would seasonally (May 15-October 15) prohibit exploratory drilling in Dease Inlet, Admiralty Bay, and Elson Lagoon and associated islands, and prohibit wellheads and most other permanent development facilities from being placed on the seaward side of the coast in these areas, up to three-quarters of a mile out. However, Alternative A would allow pipelines in those waterbodies, and other permanent facilities beyond the three-quarter-mile buffer, limiting its effectiveness in spill avoidance.

These stipulations, combined with the temporary deferrals and numerous required operating procedures designed to prevent and handle spills (e.g., A-3 through A-6), would minimize the risk that large numbers of seals would come into contact with contaminant spills.

Seals exposed to petroleum products could suffer kidney and liver damage from ingestion during feeding (Cornelius and Kaneko 1963, Geraci and Smith 1977, Holden 1978), and irritation to eyes, mouth, lungs, and anal and urogenital surfaces (St. Aubin 1990). A statistically significant chance of mortality exists for exposed individuals. Harbor seals observed immediately after oiling appeared lethargic and disoriented, which may be attributed to lesions observed in the thalamus of the brain (Spraker et al. 1994). Controlled studies by Smith and Geraci (1975) found ringed seals may develop mild liver damage, kidney lesions, and some eye damage from immersion in crude oil. Eye damage was often severe, suggesting permanent damage might occur with longer periods of exposure to crude oil; the overall severity of the injuries was most likely associated with the duration of exposure. Based on small, transient effects found in ringed seals deliberately fed potent fractions of carbon tetrachloride, Geraci and Smith (1976) concluded the direct effects of an oil blowout or spill may result in transient eye damage to healthy seals in open water. Inhalation of volatile hydrocarbons, directly ingesting oil, and possibly ingesting contaminated prey could transfer toxins to body fluids and tissues causing effects that may lead to death, as suspected in dead gray and harbor seals (Engelhardt et al. 1977, Engelhardt 1982, St. Aubin 1990, Frost et al. 1994b, Lowry et al. 1994, Spraker et al. 1994, Jenssen 1996).

Pinnipeds in oil exposure experiments were able to process and excrete at least some of the ingested hydrocarbons. Engelhardt (1978; 1982; 1985) found this with seals returned to clean water after being exposed. Other studies (Engelhardt et al. 1977, Engelhardt 1982) indicate that ringed seals may accumulate compounds from hydrocarbons in their tissues, but that they are excreted via liver and kidney functions. Morphological similarities among phocid seals suggest spotted and ribbon seals would likely experience similar physiological impacts from oil exposure to that seen in harbor and ringed seals.

Marine contamination large enough to cause a decline in prey resources would likely lead to lower survival and recruitment in the regional seal populations. Due to the coastal dwelling and highly migratory nature of Alaska spotted seals, a large-scale spill reaching marine waters has the potential to impact a substantial number of spotted seals in this region and lead to the temporary displacement or loss of this portion of the Alaska spotted seal stock. The extent of impacts would depend upon the type and amount of materials spilled, location of the spill, spill rate, time of year, weather conditions, and effectiveness of the response.

Effluent discharge from marine vessels supporting drilling and production operations could be of concern for ribbon and spotted seals. Ballast water from marine traffic has the potential to transport organisms foreign to the arctic marine ecosystem, and wastewater discharge could potentially introduce new pathogens into the system (McGee and Loehr 2003, West 2004). Pathogens such as viruses spread through fecal contamination survive better at low temperatures under low light conditions (Fong and Lipp 2005), which are present in the arctic environment for a majority of the year. Recently, new unidentified diseases and parasites have been noted in ice seal species[4]. The source of these pathogens and parasites is unknown, but may be associated with increased shipping traffic and discharge of marine waste into the system. The introduction of new organisms and pathogens to the arctic environment could result in the death of many spotted and ribbon seals, affecting seals at the population level. Under Alternative A, Required Operating Procedures A-2, 6, and 7 will ensure that discharge is unlikely to occur at development and production facilities, but fail to regulate discharge of supporting vessel traffic beyond the provisions in Required Operating Procedure A-2d. There are currently no provisions within the Required Operating Procedures directly regulating ballast water discharge. The U.S. Coast Guard, however, published a final rule in March 2012 amending its regulations on ballast water management to include standards for allowable concentrations of living organisms in ballast water and an approval process for ballast water management systems (USCG 2012).

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[4] http://www.fakr.noaa.gov/newsreleases/2011/umedeclaration2011.htm

Effects of Abandonment and Reclamation

Effects of abandonment and reclamation would be similar to those found under development and production. The greatest concerns for ribbon and spotted seals would be the disturbance of spotted seals on terrestrial haulouts, the potential for large oil spills, and possible introduction of new biota to the system from discharge related to shipping.

4.3.10.3 Effectiveness of Stipulations and Required Operating Procedures

Baleen Whales

Under Alternative A, lease stipulations would help prevent spilled fuel, oil, or other toxic materials from reaching the marine environment, minimizing potential effects to individual protected whales.

Required Operating Procedure F-1 requires, in most cases east of Peard Bay, aircraft to maintain an altitude of 1,500 feet above ground level. This would essentially eliminate disturbance to migrating or feeding whales in nearshore areas such as Cape Simpson and Lonely.

Stipulation K-3 is designed to “protect fish and wildlife habitat, preserve air and water quality, and minimize impacts to traditional subsistence activities and historic travel routes on Dease Inlet, Admiralty Bay, and Elson Lagoon.” This would reduce impacts on protected whale species feeding and/or migrating in the nearshore waters between Cape Simpson and Point Barrow.

Stipulation K-6 (Coastal Area) includes as one of its objectives “to prevent contamination of marine waters” by preventing permanent facilities from being constructed within three-quarters of a mile from the coast. This could reduce potential impacts on coastal feeding gray whales and their habitat in the western Beaufort Sea near Barrow and Peard Bay in the northeast Chukchi Sea. This would not, however, preclude a pipeline coming ashore connecting offshore leases with onshore infrastructure.

Toothed Whales

Under Alternative A, Required Operating Procedures A-1 through A-11 address waste prevention, handling, disposal, oil spills, and public safety. These required operating procedures will help prevent spilled fuel, oil, or other toxic materials from reaching the marine environment, minimizing potential effects to beluga whales, harbor porpoises, and killer whales. Required Operating Procedure F-1 minimizes effects from low-flying aircraft by restricting flight altitude in some locations of the NPR-A and minimizing the number of flights. Lease stipulation K-3 will protect habitat in Dease Inlet, Admiralty Bay, Elson Lagoon, and associated barrier islands. Oil and gas operations will generally not be allowed here during the open-water period when belugas might be present. Finally, stipulation K-1 and K-6 will help protect coastal and marine habitats and reduce possible contamination by preventing permanent facilities from being constructed near certain rivers and within three-quarters of a mile from the coast. However, K-1 only protects a subset of all rivers in the planning area, and in fact protects fewer rivers under Alternative A than with any of the other alternatives.

Ice Seals

Stipulations K-8b for the Kasegaluk Lagoon Special Area and K-3b for Dease Inlet, Admiralty Bay, Elson Lagoon, and inland of barrier islands would effectively minimize impacts to seals in these areas. However, spotted seals use terrestrial haulouts outside of these areas, and these would not be protected. Discharge from support vessels may not be effectively regulated through the A-series required operating procedures, and could result in impacts to both species. Stipulations K-1 and K-6 will help minimize the chance of contaminating coastal and marine habitats and reduce possible contamination by preventing permanent facilities near certain rivers and within three-quarters of a mile from the coast. However, under Alternative A, K-1 protects only 24 rivers in the planning area, which is half of what is named in all other alternatives.

Stipulation K-3b may help limit aircraft disturbance at seal haulouts, as it states these activities shall be conducted to minimize impacts to concentrated wildlife resources. However, it lacks specificity such as a recommended buffer distance. Stipulation F-1 strives to minimize effects of low-flying aircraft on specific wildlife, but does not specifically list marine mammals as an intended benefiter.

4.3.10.4 Conclusion

Baleen Whales

The most likely effects of Alternative A on gray and minke whales are disturbance-related effects from marine shipping/barging; occasional vessel collisions are possible, but unlikely. Short-term avoidance behaviors including dives, direction changes, and temporary abandonment of areas may occur as the result of ship or aircraft traffic. Studies have not been conducted on the long-term effects on gray and minke whales from disturbance from aircraft and shipping traffic, but the number of activities associated with the NPR-A activities that may cause disturbance are expected to be few, limited seasonally, and generally in areas/times where whales are not concentrated. Spill analysis suggests that a terrestrial spill large enough to reach areas used regularly by whales is very unlikely. In-water spills (i.e., ship accidents or nearshore lease spills) cannot be discounted nor easily predicted and could have severe localized effects, but are generally expected to be unlikely. As previously noted, powerful summer and fall storms could drive barges ashore, as happened in August 2000. Vessel strikes are the most likely impact to whales that may result in serious harm or death. They also appear to be rare, but may occur at higher frequencies if barge traffic increases in the future.

Under Alternative A, the effects of non-oil and gas activities on baleen whales, would likely be short-term and localized and occur within 1 mile of aircraft corridors, survey sites, recreational camps, and overland moves. The effects of oil and gas leasing and development activities would likely cause increases in noise and disturbance, primarily near Lonely, Cape Simpson, Point Barrow, Wainwright, and along shipping lanes. Effects would be somewhat localized (within approximately 2.5 miles of barging lanes) and limited to the summer open-water period (Richardson and Malme 1993).

The effects of development under Alternative A on gray and minke whales would likely be short-term. If these whale species become more common in the Chukchi Sea as appears to be the trend in recent years—likely related to a warming climate—there may be a higher encounter rate with NPR-A shipping traffic than might otherwise have been the case. Overall, it is not expected that NPR-A oil and gas exploration and development activities under Alternative A would have measurable population-level effects on non-special status whale species; however a few whale-vessel collisions may occur with lethal or sub-lethal effects.

Toothed Whales

Impacts to belugas, narwhals, harbor porpoises, and killer whales could occur under Alternative A through a variety of means. The most likely impact to Arctic toothed whales would be brief displacement from preferred habitats or disturbance to normal behavior due to anthropogenic sounds.

Under Alternative A, the effects of non-oil and gas activities on beluga whales would likely be displacement, deflection of migration, or lost feeding opportunities due to sounds produced from aircraft or human presence in coastal areas. The effects of oil and gas activities would likely cause increases in noise and disturbance, also resulting in possible displacement, deflection of migration, and lost feeding opportunities. Studies of disturbances suggested that impacts to belugas are short term-and localized, and no studies are available indicating long-term effects or underwater behavioral changes could result from these activities. Similar effects are possible for the other species, although their frequency of occurrence, especially for narwhals, is comparatively low and inconsistent to render such effects unlikely.

The effects of development within the NPR-A under Alternative A on beluga whales or other toothed whales would depend on the location of the gravel pads. Pads near beluga concentration areas could cause permanent displacement from that area, although the stipulations would likely prevent a pad from being constructed near a beluga concentration area.

Some beluga whales could be affected by oil spills in rivers that carry spilled oil to the marine environment or coastal areas. The number of animals affected by spilled oil would depend upon the number of animals present, spill size, location, and timing of such an event. If enough of the spill reached the ocean at a concentration area or feeding aggregation, many animals could be exposed. An oil spill is unlikely, but if it did occur, there could be some mortality and longer-term impacts to reproduction or survival of some individuals, but not the population. The extent of impacts would depend upon the size of a spill and the number of individuals present in nearshore areas when most of the belugas, harbor porpoises, and killer whales are in offshore waters. Molting areas such as Kasegaluk Lagoon are exceptions to this and many belugas concentrate there at certain times of the year and are vulnerable to spilled oil. Most on-shore winter spills would not have any effect on toothed whales if they are cleaned up before spring break-up, since toothed whales are mostly absent from the Beaufort and Chukchi seas, wintering south in the Bering Sea.

There are limitations to what is known about the population sizes and trends, distributions, movements, habitat use, response to anthropogenic activities and other aspects of the biology of beluga whales, narwhals, harbor porpoises, and killer whales. Studies of the long-term effects on these animals from short-term or chronic exposure to sound have not been conducted. However, if short-term observations of belugas being disturbed at the surface are indicative of longer-term disturbances, the effects from Alternative A would likely be brief and localized. Assuming there are no major oil spills, overall, it is not expected that activities under Alternative A would have a population-level effect on Arctic toothed whales.

All of the above impacts will add to a range of potential impacts to these species related to climate change, including potential increased predation, changes in food availability or composition resulting in changes to body condition and health, increased competition, and exposure to novel diseases.

Ice Seals

Under Alternative A, the greatest effect to spotted seals from non-oil and gas-related activities will likely be in the form of haulout disturbance by aircraft and marine vessel traffic. This will likely be short-term and localized. Ribbon seals are unlikely to be affected by non-oil and gas activities due to their pelagic nature. Impacts to spotted seals from oil and gas activities will be similar to non-oil and gas activities, but will also include increased traffic, the chance of an accidental large or very large contaminant spill, higher potential for the introduction of pathogens from increased marine vessel traffic, and a potential reduction in prey base. These impacts cannot be accurately predicted, but large numbers of spotted seals could be affected if perturbations occur at major haulouts where seals congregate during the open-water season. Due to their absence from the nearshore area, ribbon seals would only be likely to experience adverse effects if large contaminant spills reached marine waters or new pathogens were introduced to the system.

Climate change effects—particularly loss of habitat due to diminishing sea-ice extent and concentration—could exacerbate effects of development on habitat use, quality, or availability for ice seals. Spotted seals may be more susceptible to these effects than are ribbon seals due to their nearshore distribution and greater frequency of occurrence in the NPR-A project area. How either species will respond to changes in sea ice conditions is speculative. Spotted seals have the capacity to adapt and use other haulout substrates such as terrestrial areas. This could, however, put them at greater risk from onshore disturbances. The mechanisms by which effects of climate change and anthropogenic activities interact are unknown and could range from synergistic to countervailing.

4.3.10.5 Potential New Mitigation Measures

Potential Mitigation Measure 1-- Aircraft Avoidance of Seal Aggregations (Addition to F-1 Required Operating Procedure)

Objective: (same)

Requirement/Standard: (add; note this would be subparagraph f for the Northeast NPR-A portion in Alternative A)

g. Aircraft traveling along the coast and shore fast ice zone shall maintain a minimum altitude of 3,000 ft. and a buffer of 1 mile from aggregations of seals unless doing so would endanger human life or violate safe flying practices.

Potential Benefits and Residual/Unavoidable Impacts: Whereas the potential exists for aircraft to cause serious adverse effects to individuals or groups of ice seals on terrestrial and ice haulouts due to disturbance and loss of resting opportunities, that potential can be largely minimized with appropriate mitigation techniques, such as minimum altitude and distance requirements for aircraft in the vicinity of terrestrial or ice haulouts. Ice seals on terrestrial haulouts may not always be readily identifiable if they are in small numbers. However, seals tend to return to the same areas to haulout and as such once a haulout area is identified pilots should follow the above listed mitigation measure. Seals hauled out on ice platforms are readily identifiable at great heights and as such should be easily avoided. While this mitigation measure is intended mainly to protect spotted seals, other marine mammals such as other ice seals, walrus, and polar bears utilizing these areas would also benefit from this mitigation measure.

Potential Mitigation Measure 2—Marine Vessel Avoidance of Terrestrial Aggregations of Seals (Addition to K-6 Stipulation - Coastal Area)

Objective: (same)

Requirement/Standard: (add) Marine vessels shall maintain a 1-mile buffer from the shore when transiting past an aggregation of seals (primarily spotted seals) using a terrestrial haulout unless doing so would endanger human life or violate safe boating practices. Marine vessels shall not conduct ballast transfers or discharge any matter into the marine environment within 3 miles of the coast except when necessary for the safe operation of the vessel.

Potential Benefits and Residual/Unavoidable Impacts: Whereas the potential exists for marine vessels to cause serious adverse effects to individuals or groups of ice seals on terrestrial and ice haulouts due to disturbance, loss of resting opportunities, and the introduction of foreign pathogens or organisms, that potential can be largely minimized with appropriate mitigation techniques, such as minimum distance requirements for marine vessels in the vicinity of terrestrial or ice haulouts and the restriction of discharge. Other marine mammals such as polar bears and walrus using these areas would benefit from the distance buffer measure. The marine environment as a whole would benefit from required discharge measures. The discharge measure could make the operation of marine vessels more costly or inconvenient for operators but would serve as a net benefit to the ecosystem.

4.3.11 Special Status Species

The following discussion of impacts is divided into four sections that discuss special status species of plants, birds, terrestrial mammals, and marine mammals.

Within each subsection, authors describe impacts of non-oil and gas activities and oil and gas activities and the effectiveness of stipulations and required operating procedures and then provide a conclusion (where the discussion is long enough to warrant one). All potential new mitigation measures for special status species are discussed at section 4.3.11.5.

4.3.11.1 Special Status Species of Plants

Nine plant species listed as BLM Sensitive Species and their habitats are described in section 3.3.8 in Volume 1. All of these have been found within the outer boundaries of the NPR-A. An additional 12 species designated as sensitive by BLM-Alaska have been documented on the North Slope, but have not yet been documented in the NPR-A. The types of impacts to these plant species are the same as those for all other vegetation. These impacts are described in section 4.3.5 and are not repeated here.

Under Alternative A, development would be unlikely to affect any plant species' existence or any plant communities at scales larger than local effects. However, if development facilities were constructed in an area containing a population of a BLM Sensitive plant species (by definition rare), the impacts to that population, and thus, the species could be severe. Some of the habitats potentially occupied by sensitive species would be protected from development under Alternative A by setbacks along rivers and lakes. Other species occur in dry habitats associated with bluffs, floodplains, river terraces, sand dunes, rocky outcrops, and fellfields. These habitats are the primary sources of gravel fill used during construction and development (National Research Council 2003) and could be impacted by development in these areas.

4.3.11.2 Special Status Species of Birds

This section discusses the potential direct and indirect effects to special status bird species (yellow-billed loon, spectacled eider, Steller's eider, Kittlitz's murrelet, red knot, short-eared owl, and golden eagle; referred to as "special status species" below) that could result from management actions in the NPR-A under Alternative A. The species addressed in this section are migratory and do not occur in the NPR-A during winter. Two bird species found in the NPR-A and classified by BLM as Special Status Species are listed as threatened under the Endangered Species Act (ESA) (no bird species are listed as endangered). Most of the activities that could potentially affect these birds in the NPR-A would result from oil and gas exploration, development, and transport. Other activities that could potentially affect birds include permitted recreation, guided hunting, activities associated with scientific surveys and research camps, cleanup of oil and gas exploration sites, and activities associated with government actions (e.g., cleanup of abandoned well sites). These activities could affect tundra-nesting birds by causing: (1) habitat loss; (2) disturbance or displacement; (3) increased predation; and (4) direct mortality. Impacts would most often be localized and on the scale of individual birds. Impacts have potential to have greater negative effect if the activity occurs in an area of high bird density (such as near lakes containing large numbers of molting geese or shorebird staging areas) or in areas containing populations of species known to have declining populations or those particularly sensitive to disturbance.

Alternative A would make available approximately 57 percent (13 million acres) for oil and gas leasing of the NPR-A's approximate 22.8 million subsurface acres (see Map 2-2). Four special areas containing 8.3 million acres would be allocated (see section 3.3.9 in Volume 1 for more information regarding special areas). Under Alternative A, all of Teshekpuk Lake including its islands and virtually all of the goose molting area north and east of the lake would be deferred from leasing until 2018. Permanent oil and gas facilities with the exception of pipelines would be prohibited in two areas important to the movement of caribou around Teshekpuk Lake and in a 5- to 6-mile band around the southern portion of the goose molting area (see Maps 2-1, 3-14). A large area of land in the westernmost section of the NPR-A, including the Kasegaluk Lagoon Special Area and lands near Wainwright would be deferred from leasing until 2014. In addition, lease stipulations have been designated under this alternative that would help to mitigate potential negative impacts that could result from the various activities.

Activities Not Associated with Oil and Gas Development and Exploration

Ground camps associated with non-oil and gas activities include both small and large groups of people involved in scientific research, guided recreation, and hunting. These camps range in size from small mobile parties that remain at a site for only a day to larger camps that are operated for periods of up to 12 weeks. Winter camps are not often used, and when employed, would most likely be located on previously disturbed areas. Spectacled and Steller's eiders are not present in the NPR-A in the winter, so disturbance from winter camps would likely be minimal and stipulations and required operating procedures would provide protection for the habitats they use. The majority of seasonal camps would operate during the summer months. Various types of disturbances could affect threatened eiders located near summer camps. Noise and ground activities may disturb these species, causing temporary or permanent displacement from feeding, nesting, brood-rearing, or staging areas, and potentially affecting energy budgets and productivity of individuals. Although pedestrian traffic has been shown to be particularly disruptive to some waterfowl and raptors (Roseneau et al. 1981; Ritchie 1987; Johnson et al. 2003b), some birds may also acclimate to predictable daily activities of camp personnel. Aircraft activity to mobilize and resupply summer camps may disturb birds along flight corridors and near airstrips. Effects of this type of visual and noise disturbance could range from temporary displacement from preferred habitats to nest abandonment. Fixed-wing and helicopter flights for mobilization and re-supply of summer camps would be intermittent, and could occur several days or weeks apart. It may be easier for birds to acclimate to flights that occur on a regular daily basis than to flights that occur on a more random basis. Birds could also suffer mortality due to collisions with aircraft. Threatened eiders nesting near summer camps could suffer mortality or egg loss due to predation by predators attracted to anthropogenic sources of food or attraction to human presence at camps. The following required operating procedures and stipulations would mitigate the potential negative effects of activities associated with the non-oil and gas activities mentioned above: Required Operating Procedures A-1 through A-7, E-11, E-18, and L-1, and Stipulations K-7 and K-8. Nest abandonment could occur if nests are located in areas with high levels of activity. If possible, summer camps would be located in areas away from the breeding habitats of threatened species to minimize potential effects of disturbance. Impacts would likely be localized and restricted to within about a mile of activities at the camp.

Summer boat traffic could occur on the Colville, Kogosukruk, Kikiakrorak, Kuk, Mead, Utukok, Inaru, Ikpikpuk, and other rivers for permitted recreation, guided hunting, or to re-supply camps located along these rivers. Numerous studies have reported on the effects of boat disturbance to birds (e.g., McGarigal et al. 1991; Steidl and Anthony 1996). Fuel spills due to summer boat traffic are expected to be small (less than 5 gallons), and would most likely occur during fuel transfers. Fuel spills due to summer boat traffic are expected to be small (less than 5 gallons), and would most likely occur during fuel transfers. Fuel spills have the potential to negatively impact birds if they occur in areas where the birds are feeding (contamination of prey items) or if fuel comes into contact with and adheres to the birds feathers. Any such losses would negatively impact individuals and would not be likely to have an effect at the population level. The following required operating procedures and stipulations would mitigate the potential negative effects of activities associated with the nonoil and gas activities mentioned above: Required Operating Procedures A-1 through A-7, E-11, E-18, and L-1, and Stipulations K-7 and K-8. Unless a fuel spill occurred in an area where large numbers of threatened eiders congregated, any such losses would negatively impact individuals and would not be likely to have an effect at the population level, although loss of individuals would contribute to the cumulative effects to threatened eider populations.

Aerial surveys for wildlife in the planning area could include fixed-wing aircraft and helicopter surveys. Low-level fixed-wing aerial surveys would probably have only a short-duration low-level effect on special status species, including threatened eiders, due to the short amount of time during which aircraft would be within an individual's zone of disturbance. Wildlife telemetry studies involving relocation of birds using radio telemetry could cause greater disturbance to birds due to the disturbance created by the take-offs and landings required for deploying ground personnel for attachment of transmitters. Pedestrian traffic, necessary for transmitter attachment, has been shown to be more disruptive to some waterfowl species than other types of disturbance (Johnson et al. 2003b). The following required operating procedures would mitigate the potential negative effects of activities associated with the non-oil and gas activities mentioned above: Required Operating Procedures E-11, E-18, and F-1. The effects to special status species from these activities could range from temporary displacement from preferred habitats to nest abandonment and loss of production for the breeding season. Impacts would likely be localized and on the scale of individual birds. Cleanup activities at abandoned sites in the planning area could involve the use of fixed-wing aircraft or helicopters to access the sites. The effects of this traffic would be similar to those described above for mobilizing and re-supplying summer camps. Disturbance to eiders from aircraft traffic would likely be greatest within approximately 2,300 feet of the camp, and have little or no effect beyond 6,500 feet (Johnson et al. 2003b). Available evidence suggests that helicopter and fixed-wing flights and take-offs and landings at gravel pads or airstrips do not affect distribution or reproductive success of spectacled eiders (Johnson et al. 2006; 2007). Ground activity by workers on foot could be more disruptive to some bird species than other types of disturbance (Johnson et al. 2003b). Impacts would likely be localized.

Oil and Gas Exploration and Development Activities

Exploration

Ground-based oil and gas seismic surveys and other exploration activities would occur during the winter months when special status species are not present in the NPR-A. Therefore, these activities would likely have no direct impacts on these species.

Acreage estimates and potential for impacts to birds from seismic surveys vary by alternative with Alternative A needing the fewest acres of seismic survey. Alternatives B-1, B-2, C, and D estimate increasing numbers of acres of seismic surveys (see Table 4-11).

Rolligons and track vehicles used during seismic surveys could leave tracks on tundra habitats that would be observable for several years (Kevan et al. 1995). These tracks could affect vegetation, soil chemistry, soil invertebrates, and soil thaw characteristics, key components of bird habitats. The most noticeably affected areas would include terrain with considerable microtopographic relief caused by mounds, tussocks, hummocks, and high-centered polygons. Wet areas are less likely to be affected than dry areas (Walker 1996). Snow acts as a buffer against these impacts; therefore, avoiding areas with low snow cover, in addition to using lightweight vehicles, dispersing traffic patterns, and minimizing sharp turns, could help to minimize damage to vegetation and landforms used by birds (Walker 1996). The following required operating procedures would mitigate the potential negative effects of activities associated with the oil and gas exploration activities mentioned above: Required Operating Procedures C-2 and C-4.

The use of air guns for boat-based seismic work in Teshekpuk Lake and some coastal waters during the summer could temporarily displace special status species from preferred feeding habitats while surveys were being conducted. Such a survey of Teshekpuk Lake, however, is unlikely under Alternative A because the lake would not be available for leasing. Such surveys also would not occur in several large coastal bays and lagoons because of restrictions in Stipulation K-3 (Dease Inlet, Admiralty Bay, Elson Lagoon, and associated barrier islands). Stipulation K-3b does not include Kasegaluk Lagoon and Peard Bay as those areas are deferred from activities until January 2014. After the deferral ends in 2014, Kasegaluk Lagoon and Peard Bay would not have the same protections as the areas covered by K-3b. In Alternative A Stipulation K-6 does not include Kasegaluk Lagoon or Peard Bay. Disturbance to special status species may result not only from air gun use, but also from boat activity (Rodgers and Smith 1995). Individual birds would be displaced from preferred habitats by seismic activities; it is likely that this displacement would be temporary and individuals would likely return after the air gun arrays passed through the area. Disturbance to special status species near and nesting on the shoreline could result from support activities, such as use of helicopters to transport personnel and supplies. Spectacled and Steller's eiders are known to use areas very close to and on the shoreline of Teshekpuk Lake, thus disturbance related to support activities could result in permanent or temporary displacement from nesting, feeding, staging, or brood-rearing habitats. Conducting seismic surveys after the completion of the nesting and brood-rearing period would eliminate the potential for nest abandonment and loss of productivity. The following stipulations would mitigate the potential negative effects of activities associated with the oil and gas exploration activities mentioned above: Stipulations K-3 and K-8.

Winter oil and gas exploration activities could indirectly affect threatened eiders during the summer breeding season. Ice roads, snow trails, ice runways, and ice pads are used for transportation, storage, and operation of exploratory drilling equipment. Construction of these ice roads, snow trails, and ice pads could temporarily alter tundra habitats by compressing vegetation or delaying the growth and development of vegetation due to protracted ice melt. The altered vegetation could reduce the amount of suitable habitat for nesting and foraging birds, but these impacts would likely be small and would likely persist for only 1 or 2 years (Walker et al. 1987a, b). The following required operating procedures would mitigate the potential negative effects of activities associated with the oil and gas exploration activities mentioned above: Required Operating Procedures C-2 and C-4. In areas where winter ice roads and ice pads are constructed annually, varying the location of the roads and pads as directed under the lease stipulations could help reduce potential impacts to tundra vegetation, and thus, to special status species nesting habitat. Further reduction of impacts would occur if ice road routes followed the wetter habitats to the greatest extent possible (Yokel et al. 2005).

In some cases, equipment could be stored on ice pads specially designed and constructed to last through the summer and into the following winter. The tundra under the footprint of these ice pads would be lost to birds during the course of the summer. Locating these summer ice pads in drier areas would help to reduce potential impacts to threatened eider species, as they are associated with wetter habitat types during the breeding period, but could increase the potential impacts to species that use upland habitats such as plovers and buff-breasted sandpiper. Existing gravel pads within the NPR-A could be used for year-round storage of seismic and exploration equipment. Existing pads are described in section 4.2.1.2.

Water used in the construction of ice roads and pads would be withdrawn from deep lakes in areas adjacent to the ice roads and pads. Winter water withdrawal could alter lake water levels and adjacent habitats, although flooding and recharge during spring break-up would likely minimize the potential for long-term effects (Rovansek et al. 1996). In the area of oil exploration and development closest to the NPR-A (Alpine Development), pumped lakes have recharged in the spring at levels similar to unpumped lakes (Streever et al. 2001; URS 2001; Baker 2002). Results from these studies are likely transferrable to other areas that have a high concentration of lakes; however, areas with sparse lakes will have different watershed dynamics that will require additional study. Lake recharge during spring would probably limit negative effects on invertebrate populations used for food by birds in the spring, though this has not been studied directly. The following required operating procedures would mitigate the potential negative effects of activities associated with the oil and gas exploration activities mentioned above: Required Operating Procedures B-1, B-2, C-3, and Stipulations K-1, K-2.

Potential for food (e.g., garbage) and shelter associated with winter exploration activities could attract predators such as arctic fox and raven. If these predators experience increased survival due to anthropogenic foods, increased predation pressure on special status species may result. If these predators experience increased survival due to anthropogenic foods, increased predation pressure on birds may result. However, Required Operating Procedure/Best Management Practice A-2 and, within the northeast NPR-A planning area, E-9 would require proper handling of non-hazardous waste to avoid human-caused changes in predator populations. Required Operating Procedures/Best Management Practices A-1 through A-7 in all alternatives provide protection to birds from impacts of hazardous materials associated with the exploratory drilling process, produced water, drilling muds and cutting, and from spills of fuel, crude oil, and other liquid chemicals.

Under Alternative A, it is estimated that there will be a need for 30 oil exploration wells (ground disturbance of 180 acres in the short term and less than 1 acre in the long term; see Table 4-14) and 74 gas exploration wells (ground disturbance of 444 acres in the short term and less than 1 acre in the long term). Thirty oil and 74 gas delineation wells are expected to be drilled from ice pads causing short-term ground disturbance of 180 and 444 acres, respectively; essentially no long-term ground disturbance is anticipated. Of all the alternatives, Alternative A is expected to create the second lowest amount of short-term surface disturbance with Alternatives B-1 and B-2 expected to cause the least surface disturbance (about 25 percent less than Alternative A) and Alternatives C and D are expected to cause the greatest amount of surface disturbance.

Development and Production

Gravel mining and placement for the construction of oil and gas field infrastructure (including the burial of gas pipelines) would cause the loss of special status species habitat. Potential changes in the vegetation community caused by burial of gas pipelines could also result in a loss of special status species habitat. During construction of roads and pads, tundra covered by gravel, as well as tundra associated with gravel mine sites, would be lost to use by these birds. This loss of habitat would continue through the duration of the operation of the development, and would be permanent unless habitat-restoration measures were successfully implemented after abandonment of the oil and or gas infrastructure. The potential long-term impacts associated with habitat loss could be minimized by locating gravel roads, pads, airstrips, and mine sites away from areas with high concentrations of nesting, molting, or staging special status species. In order to mitigate the potential negative effects of activities associated with the oil and gas development and production activities mentioned above, Alternative A includes stipulations that regulate the location, design, and construction of gravel roads and pads: Stipulations E-2, E-11, E-18, G-1, K-2, K-3a and b, K-4, K-6, K-8, and K-11.

Habitat Loss. Under Alternative A, it is estimated that there will be a need for 12 central processing facilities for oil development (disturbance of 450 acres in the short and long term; see Table 4-14) and 30 production pads/central processing facility/gas compressor facility for gas development (disturbance of 300 acres in both the short and long term; see Table 4-14) in the NPR-A. In conjunction with these facilities, there are other support structures such as gravel production pads, gravel runways in-field gravel roads, several types of pipelines, and other associated structures, that will also cause surface disturbances. Under Alternative A, during the production phase it is estimated that the gravel footprint (total long-term disturbance) would be 10,679 acres (see Table 4-14). If spectacled and Steller's eider densities are assumed to be 2.2 and 0.02 birds per square mile (640 acres per square mile), respectively (very high estimates based on aerial survey data; Larned et al. 2006; Ritchie and King 2003), up to 37 spectacled eiders and 0.3 Steller's eider could be expected to be displaced by the gravel footprint over the life of the plan if all development occurred in high-density eider areas. Of all the alternatives, Alternative A is expected to create the second lowest amount of long-term surface disturbance with Alternatives B-1 and B-2 expected to cause the least surface disturbance, and Alternatives C and D estimated to cause the greatest amount of both long- and short-term surface disturbance.

Some special status species that may have nested at sites previously not covered by gravel would be displaced and may not be able to find suitable habitat for breeding. Others would likely move to adjacent areas to nest. ConocoPhillips Alaska, Inc. funded studies specific to spectacled eiders at the CD-3 satellite to Alpine similar in methodology to those conducted at the Alpine central processing facility (Johnson et al. 2003). Results during years when construction was occurring indicate that spectacled eider nest density and reproductive success were not impacted by construction activities, which include a high number of rotary and fixed-wing flights (Johnson et al. 2006). The authors do caution that sample sizes were low. No spatial change (avoidance) by pre-nesting spectacled eiders of the CD-3 area or the Alpine central processing facility was detected during construction; however, the total number of pre-nesting spectacled eiders detected in a larger study area including CD-3 and the Alpine central processing facility has been declining over the previous 12 years that the survey had been conducted (Johnson et al. 2006).

In addition to permanent habitat loss, there may be a functional loss of habitat in areas near roads and pads if development-related disturbances preclude special status species from utilizing these habitats. Impacts related to habitat loss may be more severe for threatened species. Under Alternative A, this plan provides for a number of areas in which no permanent oil and gas facilities would be located, and many of these protected areas are considered to be of high value to threatened eiders. Sections of the goose molting area within the Teshekpuk Lake Special Area are considered to be very valuable for nesting spectacled eiders; this area would remain deferred from leasing until 2018. Within the Brant Survey Area (Required Operating Procedure K-4), development may be prohibited within one-half mile of brant nesting colonies and brood-rearing areas. This required operating procedure would also help protect nesting and brood-rearing spectacled eiders as these birds often nest within the boundaries of brant colonies. The Kasegaluk Lagoon Special Area would remain deferred from leasing until 2014, protecting areas of high-density nesting habitat for spectacled eiders until that time. After 2014 many protections would no longer apply to Kasegaluk Lagoon under Alternative A. Other stipulations and required operating procedures in Alternative A provide protections to some but not all threatened eider habitat in the NPR-A (Stipulations E-2, G-1, K-2, K-3a and b, K-4, K-6, K-8, and K-11). Therefore, the number of threatened eiders displaced from important habitats due to gravel placement and mining activities under Alternative A may be lower than under Alternatives C and D, although they would be greater than those under Alternatives B-1 and B-2. However, the potential effects of habitat loss under any alternative would depend on the location of the development, the types of habitat lost, and the level of bird use in the areas to be developed.

Temporary loss of habitat associated with gravel placement could occur on tundra adjacent to gravel structures, where accumulated snow from snowplowing activities or snowdrifts would become compacted and lead to a delayed snowmelt. Delayed snowmelt persisting into the nesting season could preclude special status species from nesting in those areas. Delayed snowmelt resulting from the construction and use of ice roads during winter activities could also cause temporary habitat loss. Ice roads could also cause compaction of vegetation, thereby reducing the availability of cover for nesting special status species in the ice-road footprint. Potential impacts to special status species from ice roads may be reduced by alternating ice road routes annually and by avoiding routes near known areas of high special status species concentration. Required Operating Procedure/Best Management Practice C-2 in all alternatives requires that ice roads be offset from year to year to minimize impacts to vegetation.

Water withdrawal from lakes during ice road construction could lower the level of lakes and affect special status species that use adjacent habitats, particularly small islands and shoreline areas that are used extensively for nesting by Steller's and spectacled eiders. Changes in the surface levels of lakes due to water withdrawal would be dependent on the amount of water withdrawn, the volume of the lake, and the recharge rate. Required Operating Procedure/Best Management Practice B-2 in all alternatives places restrictions on the amount of water that could be withdrawn from individual lakes. In the existing area of oil exploration and development to the east of the NPR-A, pumped lakes have recharged in the spring at levels similar to unpumped lakes (Streever et al. 2001; URS 2001; Baker 2002). There is also potential for impacts to special status species from potential impacts to food resources that may result from varying winter water levels due to pumping if recharge does not return pumped lakes to their pre-pumped levels.

Dust deposition can affect special status species habitat by causing early snowmelt, and thus, early green-up on tundra adjacent to roads and pads, which could attract species early in the season, when other areas are not yet snow-free. Dust deposition could also increase thermokarst and soil pH, and reduce the photosynthetic capabilities of plants in areas adjacent to roads (Walker and Everett 1987; Auerbach et al. 1997). Traffic levels, air traffic (including helicopters), and wind can influence the amount of dust that may be deposited adjacent to roads and pads. All of these impacts may in turn cause negative impacts to special status species habitat.

The melting of ice roads could be delayed compared to surrounding tundra, causing impoundments of water. Impoundments created by ice roads or gravel structures could cause temporary or permanent flooding on adjacent tundra. Impoundments could be ephemeral, drying up early during the summer, or they could become permanent waterbodies that would persist from year to year (Walker et al. 1987a, b; Walker 1996). The formation of impoundments could be beneficial to Steller's and spectacled eiders, both of which are known to nest in association with water, provided the water level in the impoundment does not drop below the level necessary for successful completion of the breeding cycle.

Mortality to special status species could also result from collisions with vehicles (ground and air), structures such as elevated pipelines, buildings, drilling rigs, towers, power lines if suspended, boats (including barges), or bridges. Eider mortality could result from road kills due to collisions with vehicular traffic. Within the Trans-Alaska Pipeline System, road kills were the greatest source of bird mortality, particularly along the Dalton Highway where dust shadows caused early green-up along the road that attracted birds (Trans-Alaska Pipeline System Owners 2001). However, spectacled eiders are primarily aquatic foragers (Petersen et al. 2000) and are unlikely to be attracted to near road areas because of terrestrial vegetation phenology. However, they may move into early meltwater ponds adjacent to roads, possibly increasing collision risk. In addition, eiders are low-elevation fliers and will move broods between lakes so collisions are possible. Some mortality of special status species could also result from collisions with structures such as elevated pipelines, buildings, drilling rigs, towers, power lines (if suspended above ground), boats (including barges), or bridges. Quakenbush and Snyder-Conn (1993) reported that a female Steller's eider was apparently killed by a collision with an observation tower at Nanvak Bay near Cape Pierce, Alaska. Lovvorn et al. (2003) salvaged three spectacled eiders that collided with a ship during the predawn hours in the Bering Sea. Eiders have also apparently been killed after striking transmission lines or guywires in Barrow and Prudhoe Bay (U.S. Fish and Wildlife Service 2005). Birds are at risk of collisions with objects in their path, particularly when visibility is impaired during darkness or inclement weather (Weir 1976). Collisions seem to increase when objects are illuminated with constant diffuse light and the tendency for birds to be drawn to diffuse light appears to increase during foggy or rainy weather (USDOI BLM 1999b 1998). Special status species moving around within the NPR-A and traveling to and from the planning area will likely encounter structures associated with oil exploration, development, or production, and these structures may pose collision risks to these birds. However, visibility is generally good during long summer daylight hours in the Arctic, and collision has apparently been only a minor source of bird mortality associated with the Trans-Alaska Pipeline System (Trans-Alaska Pipeline System Owners 2001). In all alternatives, Required Operating Procedure/Best Management Practice E-10 requires that structures shall be illuminated in ways proven to help reduce collisions of birds.

Predators, such as ravens, gulls, arctic fox, and bear, may be attracted to areas of human activity where anthropogenic sources of food and shelter, denning, or nesting sites are present (Eberhardt et al. 1982, 1983a, b; Day 1998; Burgess 2000). The availability of anthropogenic food sources, particularly during the winter, could increase survival of these animals and contribute to increases in their population. Increased levels of predation due to elevated numbers of predators could, in turn, impact nesting special status species. In recent years, oil field operators have installed predator-proof dumpsters at camps and implemented new refuse-handling techniques to minimize the attraction of predators to the landfill. In addition, oil field workers undergo training to make them aware of the problems associated with feeding wildlife. At the Alpine field, Johnson et al. (2003b) reported that except for the nesting of one pair of ravens, the numbers of predators and levels of predation after development did not increase in the area compared to pre-development levels. In all alternatives, Required Operating Procedure/Best Management Practice A-2 requires proper disposal of refuse to avoid human-caused changes in predator populations, while A-9 requires that structures do not create denning or shelter sites for predators.

There have been some indications that researchers conducting studies on avian nest density and success may inadvertently affect the results by attracting predators to nests and broods (Bart 1977, Strang 1980, Johnson 1984, Götmark 1992). Birds that are flushed from their nests during surveys may be more susceptible to nest predation than undisturbed birds. Safine (2011) did not detect a statically positive effect of observer visitation on nest survival the day following a nest visit; however, in some cases nest visitation was clearly seen to affect nest survival. Researchers should take precautions to minimize effects to special status species although ongoing activities with repeated disturbance by researchers could cause some mortality to eggs and chicks of special status species.

Activities related to oil and gas development and production in the planning area, such as vehicle, aircraft, pedestrian, and boat traffic, routine maintenance activities, heavy equipment use, and oil or gas-spill cleanup activities could create disturbances that may negatively affect special status species. These disturbances could result in temporary or permanent displacement from preferred habitats, potentially resulting in decreased nest attendance, nest abandonment, nest predation, and increased energy expenditures that could affect an individual bird's survival or reproduction. The likelihood for and severity of impacts to special status species would vary depending on the type, duration, and location of the disturbance; the number of individuals in the area; and the time of year. Impacts would be most likely to occur if facilities were located in habitats with high concentrations of special status species.

During the summer, special status species may be subjected to disturbances caused by vehicular and pedestrian traffic, and by noise from equipment on roads or at facilities, including large trucks hauling equipment and supplies and road maintenance equipment on access roads and pads. Some evidence suggests that pedestrian traffic may have a greater impact on some species of birds than vehicular traffic. During a study of the effects of disturbance related to the Lisburne Development in the Prudhoe Bay oil field, Murphy and Anderson (1993) reported that of the more common sources of disturbance, humans on foot elicited the strongest reactions from geese and swans. Johnson et al. (2003b) reported that aircraft and pedestrians elicited higher responses by nesting geese at the Alpine field than other sources of disturbance. Johnson et al. (2003) reported that for a sample of nesting geese at the Alpine Development during the same study, the highest rates of response to potential disturbance was caused by airplanes and pedestrians, and the lowest rates of response was elicited by vehicles. Although there are no studies that have specifically looked at effects of disturbance to special status species, it would be reasonable to expect that disturbance from vehicular and pedestrian traffic could affect activity and energy budgets of these species in much the same way it has for other waterfowl. The following stipulations would mitigate the potential negative effects of activities associated with the oil and gas development and production activities mentioned above by helping to protect birds from disturbance by regulating the location of infrastructure: Stipulations E-2, F-11, K-1, K-3a and b, K-4, K-6, K-8, and K-11.

All alternatives allow summer tundra travel in the NPR-A on a case-by-case basis only after extensive studies have been conducted (Required Operating Procedure/Best Management Practice L-1). Although travel off of gravel pads is easiest in winter and generally environmentally preferable at that time, some vehicle travel off of pads does occur in North Slope oil fields during summer to accomplish specific tasks. The State of Alaska has approved some low-ground-pressure vehicles for summer tundra travel and similar summer tundra travel permit requests may be anticipated to be part of oil development in the NPR-A. The need for visual inspection of oil and gas pipelines during the period of time that the tundra is not frozen is the situation that would most likely evoke a request for summer tundra travel. Summer tundra travel poses a high potential for disturbance to threatened eiders, as a large proportion of the Alaska breeding population of this species are present in the NPR-A during this time. Disturbance from vehicles on the tundra could affect activity and energy budgets and have negative impacts on nest density and nesting success of these birds.

Activities that take place as a result of summer tundra travel could cause disturbances that may affect special status species. This disturbance could result in temporary or permanent displacement from preferred foraging, nesting, molting, staging, and brood-rearing habitats, decreased nest attendance, nest abandonment, nest destruction, nest predation and increased energy expenditures that could affect survival or reproduction. The likelihood for impacts to special status species would vary depending on the location of the summer tundra travel, number of individuals in the area, and the period of travel in relation to the breeding chronology. Impacts would be most likely to occur if summer tundra travel occurred in habitats with high concentrations of special status species.

Aircraft, both fixed-wing and helicopter, would provide access for oil and gas-related activities throughout the development, operation, and abandonment of any oil or gas field developed in the NPR-A. This could include air support for ground surveys of wildlife, archaeological, hydrological, aerial surveys and other resources; road and pipeline route surveys; pipeline inspections; and support for many other development, operation, and abandonment activities. The location, timing, and frequency of such flights and the type of aircraft used will be influenced by the phase of oil and gas development and operation, the location of any oil or gas discovered, the type of development that might occur, as well as restrictions that BLM and other regulators might place on the lessee or permittee (see section 4.2.1.2 for a discussion of potential number of flights associated with various activities). The potential for disturbance to waterfowl from aircraft is well documented (e.g., Schweinsburg 1974; Ward and Stehn 1989; Derksen et al. 1992; McKechnie and Gladwin 1993; Ward et al. 1999). Johnson et al. (2003b) conducted a study of aircraft disturbance of waterfowl at the Alpine oil field in which responses of birds to aircraft included alert postures, interruption of foraging behavior, and flight. Aircraft disturbances could displace special status species from feeding habitats and negatively impact energy budgets. Gollop et al. (1974b) and Ward et al. (1999) suggested that helicopters may be more disturbing to wildlife than low-flying fixed-wing aircraft, although Balogh (1997) indicated that fixed-wing aircraft flown at 150 feet above ground level often caused spectacled eiders to flush, while helicopters flown at similar altitudes in the vicinity of Prudhoe Bay did not. Permanent oil and gas facilities (with the exception of pipelines) would be prohibited on the lake buffers illustrated in Maps 2-1 and 2-1T, and most aircraft overflights in this area would likely be at altitudes sufficiently high to avoid disturbance to special status species (see Required Operating Procedure F-1). Aircraft disturbance would be likely to affect special status species in those portions of the NPR-A open to development, with the effects of aircraft disturbance likely being lowest in Alternative B-1, second lowest in Alternative B-2, with the most disturbance likely in Alternatives C and D.

The potential effects of routine aircraft flights into airstrips at oil and gas developments would range from avoidance of certain areas to abandonment of nesting attempts or lowered survival of young, to mortality if special status species collide with aircraft. The likelihood that noise associated with aircraft would have a negative impact on special status species would probably be greatest during the nesting period when the movements of incubating birds are restricted and the molting period when, in addition to being a period of restricted movements, birds may be energetically stressed and are known to be sensitive to disturbance. Johnson et al. (2003b) also reported on tundra swans and yellow-billed loons nesting in proximity to the Alpine field airstrip. Similarly, no evidence was found that development activities affected the distribution and abundance of yellow-billed loon nests located near the airstrip, although the sample size was small. The highest levels of aircraft noise would occur during takeoffs as engines reach maximum power levels. During landings, aircraft noise levels would be reduced as engine power decreased. In the planning area, aircraft activity would likely be greatest during the construction period, when more personnel and equipment would be transported to areas being developed than during the production period, when activity levels would be reduced (Johnson et al. 2003b). Temporary displacement from preferred nesting, feeding, brood-rearing, or molting habitats could affect energy budgets of some special status species. Any species of bird may be vulnerable to collision with aircraft under certain circumstances; in fact, it is one of the few ways that golden eagle, short-eared owl, Kittlitz's murrelet, or red knot could potentially be impacted under any alternative.

Several types of watercraft could be used during the summer and fall for transportation of equipment and supplies and for oil or gas spill response training drills. Summer and fall barge traffic would transport equipment and supplies to staging areas along the coast. For each oil or gas central processing facility that is developed, one to two sealifts (each with approximately 30 barges) would be required to transport the necessary supplies and equipment. Barges would be unloaded at staging areas along the coast and materials would be stockpiled there until being moved over ice roads to the construction location. This barge traffic could displace molting and staging special status species from preferred areas during the period mid-July through October. Displaced birds would probably move to adjacent habitats or return to their original habitats after the barges passed through the area. It is well known (Avery et al. 1980, Springer and Dailey 1980, Day et al. 2003) that birds may be attracted to sources of light with the potential for the bird to strike a structure (building, barge, tower, etc.) resulting in the possibility of mortality. There are documented accounts of waterfowl and seabirds being attracted to and colliding with ships in various light conditions (Dick and Donaldson 1978). Any species of bird may be vulnerable to collision with watercraft under certain circumstances; in fact, it is one of the few ways that Kittlitz's murrelet could potentially be impacted under any alternative.

Eiders, in particular, are thought to be susceptible to collision with human-made structures because they fly low over the water while migrating, fly rapidly when migrating, and are attracted to lights (Day at al. 2003 and references contained within). However, there is a short window of time during the fall when the planning area is dark and birds are present, thus, the potential for collisions between staging waterfowl and barges working in the planning area is low. Effects of barge traffic would vary in intensity depending on the timing, location, and duration of the traffic in areas of high special status species concentrations. The potential for the greatest frequency of disturbance to special status species from barge traffic would occur in Alternatives C and D, and would be lowest in Alternatives A, B-1, and B-2.

Oil spill response training activities using watercraft could be conducted on rivers and lakes several times during the summer open-water season. The vessels used would likely be small, maneuverable crafts, suitable for work in shallow waters, and may include airboats and hovercrafts, which are types of watercraft for which the impacts on birds in the planning area are unknown. Spill response training activities would have the potential to disturb foraging, nesting, or brood-rearing yellow-billed loon and spectacled and Steller's eiders. Boat activity can cause alert postures, disruption of feeding behavior, and flight in waterfowl (Burger 1986, Belanger and Bedard 1989, Steidl and Anthony 2000). Rodgers and Smith (1995) and Rodgers and Schwikert (2001) determined set-back distances for minimizing the potential for boat disturbance to various bird groups. Suggested buffer zones around areas of activity ranged from 325 feet for shorebirds to 600 feet for wading birds.

Abandonment and Reclamation

Oil and gas field abandonment scenarios include both active and passive reclamation strategies. Gravel pads and roads may be purposefully removed or left in place indefinitely. Revegetation could occur through intentional seeding with native vegetation or through natural colonization. Given this uncertainty, it is very difficult to determine potential effects to special status species from these unknown activities. For this document, it is assumed that all gravel will be removed after abandonment. Given that assumption, the impacts of abandonment and reclamation of oil and gas fields on special status species would be similar in many respects to those incurred by construction activity. Activities occurring in the winter would cause little disturbance or displacement, because special status species would be absent from the area. Summer road and air traffic generated by abandonment and reclamation activities could cause disturbance, displacement, and mortality to individual special status species that would be similar to, and at the same levels as that caused by traffic during construction and operations. If pads, roads, and airstrips are not revegetated, their value to special status species would be lessened. If they were revegetated without removing the gravel, the habitat would not return to its current utility for most birds. If gravel was removed, habitat similar to that currently existing in the area could be created and used by special status species, although the precise mix of habitat types would likely not be the same as what prevailed at the time of disturbance. Foam insulating materials used in pad construction could be broken up in the course of removal. Fine particles of foam not removed from the environment could be ingested by some special status species; and depending on the material's toxicity and the amount ingested, ingestion of foam could cause sickness or mortality, though the number of individual birds harmed would likely be very small. Lease Stipulation G-1 requires that upon abandonment or expiration of leases, all oil and gas facilities will be removed unless the authorized officer determines that it is in the best interest of the public to retain a structure.

Up until the time that the 2018 deferral expires, it is likely that under Alternative A fewer special status species would be impacted by development than under Alternatives C and D, because leasing would not be permitted in the area with the highest concentrations of spectacled eiders in the wetlands north of Teshekpuk Lake. Average eider density over 15 years in area north of Teshekpuk Lake is 0.82 per square mile, which is greater than the long-term average for the entire eider breeding population survey area average density of 0.57 per square mile and is the highest density strata within the planning area. This area also contains approximately 57 percent of the indicated population within the NPR-A (U.S. Fish and Wildlife Service, unpublished data). Because of the deferral of leasing of the area north of Teshekpuk Lake under this alternative, impacts to spectacled eiders are expected to be much lower than the total acre impact estimate would suggest because eiders occur at greater density (0.82 per square mile versus 0.34 per square mile) in the closed area than in the remaining planning area.

However, under all alternatives, the potential effects of habitat loss would depend on the location of the development, the types of habitat lost, and the level of special status species use in the areas to be developed. Without specific information on the locations of potential developments, the estimates of special status species (especially spectacled and Steller's eiders) potentially impacted should be seen as an index of comparison between alternatives, not an absolute value of individuals affected.

Oil Spills and Gas Releases

Crude oil spills could occur from pipelines, storage tanks, production and exploration facilities and infrastructure, drilling rigs (well-control incidents), airstrips, roads, vessels, and bridges. Spills that leave the pads and roadbeds, or enter water sources directly, could reach one or more of several habitat types, including wet and dry tundra, tundra ponds, lakes, flowing creeks and rivers, and potentially the adjacent nearshore Beaufort or Chukchi sea. Spills could occur anytime during the year. Onshore or offshore refined-oil spills could occur along ice roads, or from barges, helicopters, airplanes, gravel pad facilities, or trucks along the road system. Typical refined products spilled on the Alaska North Slope are aviation fuel, diesel fuel, engine lube, fuel oil, gasoline, grease, hydraulic oil, transformer oil, and transmission oil. Refined oil is most often spilled in very small volumes and is addressed here in conjunction with crude oil in small spill scenarios in order to address concerns about the potential chronic effects from numerous small spills. Seawater or produced or process water, used for enhancement of oil production, could be spilled within the planning area affecting tundra or freshwater habitats. The gas produced in NPR-A is expected to be dry gas (no water or condensates). There are three general types of potential gas releases from: (1) loss of well control at production areas, (2) ruptured gas pipelines, and (3) gas processing facilities. These releases would be localized to the area adjacent to the release site.

There is potential for negative impacts to special status species from oil spills of all sizes and types occurring on land or on water (lakes, streams, rivers, marine waters). Spills of crude oil and refined products onto either the tundra, freshwater, or marine environments could affect special status species through any and likely a complex interaction of the following: direct oiling of plumage, oiling of eggs, ingestion of oil, contamination of food resources, disturbance due to cleanup efforts, and long- and short-term loss or alteration of habitat due to spilled oil and cleanup activities. The extent of impacts to special status species would depend upon the type and amount of materials spilled, location of the spill and types of habitats impacted, spill rate, time of year, weather conditions, and the effectiveness of the response.

Low tundra relief and topographical features in the NPR-A would limit the spread of oil and, during the summer, coastal tundra has the ability to absorb large quantities of oil also limiting the spread of the spill. In winter, when the ground and water surfaces are frozen, spreading of oil is controlled by the snow cover or frozen soil. Snow cover can act as an absorbent, slowing the spread of oil or preventing the spill from reaching the tundra surface. Oil tends to spread on the surface of the frozen soil, and penetration of oil into the soil is limited. However, if a spill event includes aerial, pressurized discharge then even small spills can be spread over large areas. With the high-velocity, bi-directional winds on the North Slope, oil can be misted miles downwind of a leak. If a spill occurred during spring break-up, river water flooding over land combined with ice and snow damming, could cause inundate of spilled oil over a large area of tundra. Oil spills or leaks onto tundra could negatively impact birds in numerous ways. Oil could come in contact with and adhere to birds' feathers, causing the feathers to lose their insulating capabilities and result in hypothermia (Patten et al. 1991). This effect would be particularly severe for birds that come in contact with water where feather integrity is necessary to maintain water repellency and buoyancy, and could have more severe consequences in marine habitats than in terrestrial habitats. Birds could also suffer toxic effects from ingestion of oil by consumption of food contaminated by an oil spill or from oil ingestion resulting from preening of oiled feathers (Hansen 1981). Oil contacting bird eggs can cause toxic effects to embryos (Patten and Patten 1979, Stickel and Dieter 1979). Oil could come in contact with eggs directly as a result of a spill, or indirectly from oiled feathers of incubating adults.

Oil spilled on land could also enter a lake or pond and be contained by the banks of these waterbodies. Because of the increased viscosity of oil in cold water, oil spreading on the water surface would be restricted in most waters within the planning area. Oil spilled into moving water (rivers or streams) would be subjected to the dynamics of the moving water environment where the spreading of the oil would be mandated by the surface currents and other forces within the moving water making estimates of movement rates, duration of threat, and understanding of when to discontinue spill containment and cleanup activities difficult.

Effects to special status species from oil spilled into freshwater could be more severe, depending on the time of year, than those of a spill on tundra. During spring and fall, yellow-billed loons and spectacled and Steller's eiders tend to use rivers, streams, and lakes as transportation corridors and gathering places. An oil spill occurring during these periods would have the potential to negatively affect large numbers of individuals. The potential for an oil spill to enter major rivers or streams would be minimized by a number of required operating procedures and stipulations. In all alternatives, Required Operating Procedure/Best Management Practice A-5 prohibits refueling of equipment within 500 feet of an active floodplain. Stipulation E-2 prohibits permanent oil and gas facilities including roads airstrips and pipelines with 500 feet of fish-bearing waterbodies in all alternatives. All alternatives contain Stipulations K-1 and K-2, which protect rivers and lakes, respectively, by prohibiting permanent oil and gas facilities including roads, airstrips, and pipelines within specified distances from specific rivers (variable by alternative) and from within one-quarter mile from any deep water lakes. In Alternative A, Stipulation K-4 protects waters within the goose molting area (an area used by spectacled eiders) by prohibiting permanent oil and gas facilities including roads and airstrips but not pipelines from the buffer zones established for the area.

However, if oil were spilled during the winter and not completely cleaned up or spilled during the spring break-up, free-flowing water could carry oil to streams and rivers.

Oil spilled (from a barge or support vessel) or transported into marine habitats would have the potential to spread oil over a larger area than in terrestrial habitats due to winds and currents; therefore, birds found in marine habitats within the NPR-A could be particularly susceptible to the negative impacts of an oil spill. An oil spill in coastal zone and nearshore habitats of the Colville River Delta, Harrison Bay, Smith Bay, Dease Inlet, Elson Lagoon, or Kasegaluk Lagoon, which support large congregations of threatened eider species, could affect large numbers of individual birds. Cleanup of spilled oil during ice-covered periods or periods of broken ice will be difficult, and oil may linger well into the spring/summer sea ice melt period. If oil is present in the marine environment, it will be hazardous to eiders migrating and staging in the spring or fall. Lingering effects from a winter marine spill could impact threatened eiders returning during the following breeding season if cleanup activities did not adequately remove contaminants from eider habitats and food sources.

Oil spill response activities on land, rivers or in marine waters would disturb special status species if they were present in the spill area. The extent of the disturbance would depend upon a variety of factors, including spill size and location, response actions, weather and season. Aircraft, pedestrians, watercraft, or overland vehicles would temporarily disturb special status species present in the vicinity of the spill. Response to disturbance could last from a few minutes to a few hours to multiple days. Displacement of special status species could occur on a temporal scale of a few days to the duration of the period that animals would be present in the spill area in that year. Depending on the location, size, and timing of the spill, special status species may be affected by loss of life, reduced survival, reduced future breeding opportunities, loss of yearly nesting attempt, loss of brood, or loss of body condition. McDonald et al. (2002) developed a hypothetical spill scenario involving terrestrial and aquatic spills in the Prudhoe Bay area that covered 24 and 186 acres, respectively. Assuming a nest density of 0.6 nests per acre on 145 acres of tundra covered by a terrestrial oil spill, approximately 87 nests would be affected by the spill (McDonald et al. 2002). In most cases, onshore oil spills would not be expected to affect special status species directly through ingestion of oiled prey items. For large spills that are not immediately or successfully cleaned up, the potential for contamination would persist for a longer time, and there would be a greater likelihood of special status species being exposed to the oil through ingestion of contaminated prey items. Cleanup success would likely vary depending upon the environment (see section 4.3.5 regarding effects of oil on different types of vegetation). Terrestrial habitat would be lost for use by special status species during the spill, cleanup, and some period after the cleanup while vegetation recovery is occurring. Over time, any remaining oil would gradually degrade. Although oiling of special status species would be unlikely to remain a threat after cleanup efforts, although some toxic products could remain for some time. Depending upon the spill environment, a portion of the oil could persist for at least five years (see section 4.2.1.2).

The assumed volume of small crude and refined oil spills over the life of the development in the NPR-A under Alternative A is estimated to be 717 barrels. This estimate is quite close to the estimates for Alternatives C and D (702 and 755 barrels, respectively). The estimate for Alternative B-1 is 500 barrels, and B-2 is 546 barrels.

Because of the relatively small volumes involved, management practices, and the substantial emphasis that is placed on oil-spill response plans and procedures, small crude and refined-oil spills associated with Alternative A would not likely have a measurable effect on special status species at a population level in the NPR-A, although effects to individuals could range from short-term disturbance to death. Many independent factors will determine the probability that birds will be negatively impacted by a small oil spill, including the quantity spilled, season, location (e.g., land versus water), and proximity to sensitive habitat. Potential for impacts to special status species from small crude or refined-oil spills under Alternative A would be slightly lower as compared to Alternatives C and D, but greater than under Alternatives B-1 and B-2.

The assumed volume of large crude oil spills over the life of the development in the NPR-A, under all alternatives, is estimated to be 6,000 barrels from an estimated one large crude spill. Although the estimated large spill volume is the same for all alternatives, the probability of a spill occurring varies among Alternatives A, C, and D (37, 37, and 39 percent chance of a spill, respectively) and Alternatives B-1 and B-2 (28 and 30 percent, respectively). Even with the protection of particularly sensitive areas (coastal shoreline, goose molting area), management practices, and the substantial emphasis that is placed on safe-guarding against an oil spill, oil-spill response plans and procedures, a large crude oil spill, if it occurred, associated with Alternative A could have a measurable effect on some special status species at a population level in the planning area, and the effects to individual birds could range from short-term disturbance to death. Impacts to yellow-billed loons and spectacled and Steller's eiders on a population level could also occur if oil from a large spill entered rivers, important molting or brood-rearing lakes, or marine areas during periods when large proportions of the populations of those birds were present. Many independent factors will determine the probability and extent to which special status species will be negatively impacted by a large oil spill, including the quantity spilled, season, location (e.g., land versus water), and proximity to sensitive habitat. An oil spill spreading into offshore waters of Harrison Bay during the fall molting and staging period would have the potential to affect a greater number of spectacled eiders than a nearshore spill (Fischer et al. 2002). Stehn and Platte (2000) developed an oil spill scenario for the central Beaufort Sea for the proposed Liberty Project based on a spill size of 5,912 barrels. When taking spectacled eider densities in the Beaufort Sea into consideration, the highest mean number of spectacled eiders exposed to oil was two birds. There is some evidence, however, that spectacled eiders can occur in flocks in offshore Beaufort Sea habitats (Fischer et al. 2002). Under such a scenario, an offshore spill could impact more individuals than predicted by Stehn and Platte (2000). After the lifting of the 2018 deferral impacts to special status species from large crude or refined-oil spills under Alternative A would be greater than under Alternatives B-1, B-2, and C, but less than under Alternative D.

If seawater were used for enhancement of oil production, a saltwater spill could occur within the NPR-A. Spills of seawater and produced water are soluble and mobile in non-frozen soils. Flushing with water can return surface soil salinity to near-normal conditions within 30 days in wet tundra, but salt may persist longer at moist or dry sites (Simmons et al. 1983). According to McKendrick (2000), brine spills kill plants on contact and increase soil salinity to the point that many species cannot survive. Unlike oil, salts are not biodegradable, and natural recovery occurs only after salts have leached from the soil. A spill would have effects on salt-intolerant vegetation near the seawater spill, but the amount of tundra habitat affected would likely be no more than a few acres. Thus, unless a seawater spill occurred in an area of high density, nesting cover for special status species in the planning area would not likely be affected.

The assumed volume of large (500 barrels or more) produced water or seawater spills for the development life of the NPR-A under all alternatives is estimated to be 1,900 barrels from one spill. Although the estimated spill volume is the same for all alternatives, the probability of a spill actually occurring varies between Alternatives A, C, and D (55, 54, and 57 percent, respectively) and Alternatives B-1 and B-2 (43 and 44 percent, respectively). Many independent factors will determine the probability and extent to which special status species will be negatively impacted by a seawater spill, including the season and proximity to sensitive habitat. After the lifting of the 2018 deferral, impacts to special status species from a seawater spill under Alternative A would be less than under Alternative D, but greater than under Alternatives B-1, B-2, and C.

There are three potential ways that gas releases could occur in the NPR-A from: (1) loss of well control at production areas, (2) ruptured gas pipelines, and (3) leaks at gas processing facilities. Gas releases could occur at any time of the year and these releases would be localized to the release site. It is estimated that there would be one gas release incident during the life of gas development in the NPR-A. Methane (primary component of natural gas) is lighter than air and tends to rise and dissipate into the atmosphere. The main hazard associated with natural gas is its flammability. If an ignition source exists, a release of gas can result in an immediate fire or explosion near the point of the release and the thermal effects would be expected to reach within 500 meters of the ignition source. Due to the localized nature and short duration of a gas release, effects to special status species would likely be much less severe and of a much shorter duration than those from an oil spill. A small number of individual birds could be injured or killed by an explosion; however, a population-level response would not be expected.

Human response activities to a gas release would disturb special status species if they were present in or near the release area. The extent of the disturbance would depend upon a variety of factors, including release from a buried or aboveground pipeline, release size, duration and location, response actions, weather, and season. Aircraft, pedestrians, watercraft, or overland vehicles would temporarily disturb special status species present in the vicinity of the release. Response to disturbance could last from a few minutes to a few hours to multiple days. Displacement of eiders could occur on a temporal scale of a few days to the duration of the period that individuals would be present in the release area in a given year. Depending on the location, size, and timing of the release, special status species may be affected by loss of life, reduced survival, reduced future breeding opportunities, loss of yearly nesting attempt, loss of brood or loss of body condition. Any emergency repair of a buried pipeline that would occur in summer has the potential to disturb nesting, brood-rearing, feeding, staging, or molting special status species.

A gas release from a well is expected to last one day and to release 10 thousand cubic feet of gas while a release from a transmission pipeline or processing facility is estimated to release 20 thousand cubic feet over a few hours. Although the estimated release volume is the same for all alternatives, the difference in the estimated number of gas production pads and lengths of various pipelines would change the probability of a release among the alternatives. Impacts to birds from a gas release under Alternative A would be less than under Alternatives C and D, but greater than under Alternative B-1 and B-2.

Effectiveness of Stipulations

Numerous lease stipulations and required operating procedures in Alternative A were developed to effectively protect special status species and their habitats within the NPR-A. These include Required Operating Procedures A-1 through A-7 and E-9, which ensure that solid, liquid, and hazardous wastes (including fuels) do not impact special status species or their habitats, and to reduce the potential for garbage and shelter sites that attract animals that may prey upon eiders to exploration and development sites. The protection of bird habitats and food sources are addressed by Required Operating Procedures B-1, C-3, C-4, K-3, K-4 and Stipulations E-2, L-1, and Protection J, among others. Required Operating Procedures E-11 and E-18 will help minimize the take of special status species and reduce impacts to nests and brood-rearing areas. A series of lease stipulations provides additional protections in biologically sensitive areas, and many provide protections to bird habitats and food sources. In the Kasegaluk Lagoon Special Area, there are protections in place that will protect threatened eiders through a deferral of leasing until 2014, and after that deferral is lifted, there is a prohibition on locating oil and gas facilities within the boundaries of the Special Area (Stipulation K-8). The Teshekpuk Lake Special Area and the goose molting area within the Teshekpuk Lake Special Area provide numerous protections to special status species and their habitat. Much of the Teshekpuk Lake Special Area north and east of the lake is deferred from leasing until 2018. The goose molting area is further protected by Stipulations K-4 and K-11, which prohibit permanent oil and gas facilities (with the exception of pipelines) near goose molting lakes and, among other things, restricts the total area that can be developed within areas which are used by nesting spectacled eiders. In addition, there are numerous required operating procedures and lease stipulations that regulate the types of activities that can occur near waterbodies, including rivers and streams, types of equipment that can be used, and types of exploration and development activities that can be conducted in the planning area, to protect special status species and their habitats.

Finally, Alternative A provides land deferrals, stipulations, and required operating procedures that provide protection that is superior to that provided by Alternative D, but provides fewer protections than those contained in Alternatives B-1, B-2, and C. As there has been no oil or gas development yet in the NPR-A, it is difficult to determine the effectiveness of the above-mentioned required operating procedures and stipulations. Required operating procedures and stipulations that have been in effect in the NPR-A to date regulate exploratory activities, and thus far seem to be effective in protecting special status species and their habitats.

Conclusion

Although Alternative A is the "no-action" alternative in this IAP/EIS, there could be substantial activities, especially if gas is developed. Under Alternative A, approximately 57 percent (13 million acres) of the NPR-A's approximately 22.8 million subsurface acres could be offered in future oil and gas lease sales, though approximately 2 million acres of the available lands would remain deferred from leasing until 2014 or 2018, and a corridor for infrastructure associated with offshore development in the Chukchi Sea could be accommodated.

Special status species could be affected by oil and gas activities in the NPR-A. These species migrate to wintering areas located outside of the planning area and would not be directly affected by winter exploration or construction activities, although their habitats could be affected. Summer fixed-wing or helicopter aircraft activity in support of oil and gas exploration, including related research, could result in disturbance to special status species, causing temporary or permanent displacement from preferred feeding, nesting, staging, or brood-rearing habitats in localized areas near areas of activity. Most aircraft disturbance during exploration would be confined to the area within approximately 2,300 feet of the site, and little disturbance would be likely beyond 6,500 feet. Predators attracted to areas of human activity could also impact special status species by causing depredation of eggs and young; however, lease stipulations designed to eliminate attraction of predators to camps or equipment maintenance sites would help to mitigate potential increases in predators. Lease stipulations and required operating procedures regulating exploration activities are considered effective at protecting birds and their habitats.

Non-oil and gas activities that could potentially affect special status species include permitted recreation, guided hunting, activities associated with scientific surveys and research camps, cleanup of oil and gas exploration sites, and activities associated with government actions (e.g., cleanup of abandoned well sites). These activities could affect tundra-nesting birds by causing: (1) habitat loss, (2) disturbance or displacement, (3) increased predation, and (4) direct mortality. Impacts from these activities would most often be localized and on the scale of individual birds.

Activities related to oil exploration, development, and production, such as vehicle, aircraft, pedestrian and boat traffic, summer tundra travel, routine maintenance activities, heavy equipment use, facility noise, and oil spill cleanup activities could cause disturbances that would affect special status species. Most vehicle disturbance would likely be confined to areas within 160 to 685 feet of roads and pads. Disturbance related to aircraft activity would likely be confined to areas within 2,300 feet of landing strips and little disturbance would be likely beyond 6,500 feet (Johnson et al. 2003). Pedestrian traffic would be likely to cause more disturbance than other activities, as special status species are less likely to acclimate to foot traffic than to routine aircraft or vehicular activity and to equipment or facility noise. Barges and other vessels could temporarily displace yellow-billed loons and spectacled and Steller's eiders from preferred offshore and nearshore feeding, staging, brood-rearing, or molting areas. However, displaced birds would likely move back to preferred areas after vessels passed through the area or continue to use adjacent areas, and the effects of occasional vessel traffic would likely be minimal. Effects may increase if vessel traffic becomes more that occasional. Smaller watercraft on rivers or lakes used during oil spill cleanup or training exercises may also cause disturbance to special status species. Surveys conducted prior to development would help identify areas with low levels of use by special status species that would be suitable for oil spill training activities and cause the least impact to. Conducting activities during time periods of low bird activity (i.e., post fledging) may also reduce the potential impacts of spill exercises.

Permanent habitat loss would result from gravel placement for roads and pads, and at gravel mine sites. Temporary habitat loss or alteration could also occur in areas adjacent to gravel roads due to snow and/or dust deposition, thermokarst, and the formation of impoundments. It is unknown how some types of habitat alteration, such as the formation of impoundments, would affect spectacled or Steller's eiders. Withdrawal of water from source lakes during winter could impact special status species if water levels or prey availability in source lakes were affected. Lake surveys conducted prior to water withdrawal, State of Alaska regulations and this alternative's limits on the amount of water that may be withdrawn from lakes, and the ability of lakes to naturally recharge, would likely negate any potential negative impacts related to water withdrawal.

Bird mortality could result from collisions with vehicular or vessel traffic, with towers, buildings, pipelines, power lines suspended from pipelines, bridges, or other facilities. However, it is expected that collisions would only be a minor source of bird mortality. Mortality of special status species could also result from the attraction of predators to areas of human activity. Adherence to lease stipulations that require proper disposal of garbage to avoid human-caused changes in predator populations would likely minimize potential impacts to special status species from increased predation pressure. Additional mortality could result from subsistence hunting activities if oil field infrastructure were to provide hunters with access to previously inaccessible areas. Typically, however, subsistence users tend to hunt and fish away from oil and gas infrastructure (see section 4.3.12.3).

An oil spill or gas release could impact special status species using terrestrial or marine habitats. Potential impacts to special status species would depend on the location and size of the spill and on the time of year. Due to the actions of wind and currents, a marine spill would have a greater potential to spread to a large area than a terrestrial spill. A marine spill could impact large numbers of staging or molting yellow-billed loons, spectacled or Steller's eiders.

In general, impacts to special status species from non-oil and gas activities, and from oil and gas activities, would be additive. Potential impacts from seismic activity would vary by alternative with Alternatives A, B-1, and B-2 each expecting to require five exploratory and six developmental seismic surveys (Alternatives B-1 and B-2 are expected to require greater area coverage by seismic survey than does Alternative A, so the total area impacted in Alternatives B-1 and B-2 will be larger than that in Alternative A; see Table 4-11). Alternatives C and D are estimated to require 14 and 16 total seismic surveys, respectively, which will cover a greater area than would be needed in Alternatives A, B-1, or B-2. The expected number of oil and gas fields and the level of development under Alternative A would be lower than under Alternatives C and D, but greater than under Alternatives B-1 and B-2. Therefore, it is expected that the potential effects of disturbance, habitat loss and alteration, and mortality due to development under Alternative A would be lower than under Alternatives C and D, but greater than under Alternatives B-1 and B-2. All alternatives would minimize unintentional take of migratory birds and conserve migratory bird populations. The special status species susceptible to the greatest amount and types of impacts include those that regularly breed on the NPR-A's tundra, where most activities would occur (i.e., Steller's eider, spectacled eider, yellow-billed loon, and short-eared owl). The remaining species (golden eagle, red knot, and Kittlitz's murrelet) would be infrequently exposed to activities, and would be susceptible primarily just to collisions and oil spills. In the absence of a large oil spill, none of the special status species would be expected to incur population level effects from full implementation of Alternative A.

Although many of the forces driving global climate regime shifts may originate outside the Arctic, the impacts of global climate change are exacerbated in the Arctic (Arctic Climate Impact Assessment 2004). Temperatures in the Arctic have risen faster than in other areas of the world, as evidenced by glacial retreat and melting sea ice. Special status species whose range in Alaska is concentrated in the Arctic may be the most vulnerable to the effects of a changing climate. These species include: yellow-billed loon, spectacled and Steller's eiders, and red knot. Effects to these special status species from climate warming may include a suite of effects, both positive and negative. A longer open-water season may increase productivity of some species of shorebirds and increase productivity in aquatic and semi-aquatic systems which provide food for yellow-billed loon and spectacled and Steller's eiders. Warmer soil temperatures are likely to increase thermokarst, and increases in sea level may inundate low-lying tundra areas, increasing salt marsh, aquatic and wet tundra vegetation types, and erosion of coastal bluffs (Arctic Climate Impact Assessment 2004), causing changes in coastal habitats that may quickly result in changes in vegetation that influence habitat suitability and availability for spectacled and Steller's eiders (Mars and Houseknecht 2007). The increasing thickness of the active layer of soil above arctic permafrost is likely to cause changes in moisture regimes and the distribution of vegetation types over much of the Arctic in coming years. Drying of wetlands would result in negative effects to spectacled and Steller's eiders that rely on shallow water and wet meadows, and shrub expansion may reduce the quality and availability of some types of habitats. Such impacts could accelerate or exacerbate changes in soil thermal regimes that occur with development, potentially leading to greater impacts to special status species habitat. Increase in human economic activities such as shipping and offshore oil and gas development may influence the abundance and distribution of predators, which may negatively affect special status species populations. These changes may be beneficial to some special status species such as those associated with boreal forest or shrub habitats (golden eagle), but a reduction in the amount of tundra habitat available could negatively impact spectacled and Steller's eiders, red knot, and short-eared owl, and add to the cumulative effects of oil and gas development. High rates of coastal erosion and storm surges have led to saltwater intrusion into freshwater habitats and such intrusions may alter foraging and brood-rearing habitats for spectacled and Steller's eiders.

4.3.11.3 Special Status Species of Terrestrial Mammals

Two species of terrestrial mammals listed as BLM Sensitive Species are described in section 3.3.8 in Volume 1. Neither of these has been found within the NPR-A in recent decades. The Alaskan hare has not been reported on the North Slope since 1951, and the Alaska tiny shrew has never been documented in the NPR-A. The types of impacts to these two mammalian species would be the same as those for all other terrestrial mammals. These impacts are described in section 4.3.9, and are repeated here only briefly.

Under Alternative A, development would be unlikely to affect either of these two species, primarily because it is unlikely that either exists in the NPR-A. This is especially so for the

Alaskan hare, since if this relatively large-bodied species occurred in the NPR-A, it would most likely have been documented one or more times in the last 60 years. It is more likely that the Alaska tiny shrew has occurred or does occur in the NPR-A without having been documented. If development facilities were constructed in an area containing a population of Alaska tiny shrew, adverse impacts to that population could occur. These impacts would most likely be manifested in the loss of habitat, and could also involve the deaths of some individuals if they were to be run over by heavy equipment during construction of development facilities.

4.3.11.4 Special Status Species of Marine Mammals

The following sections discuss the impacts to special status species:

Baleen Whales

The special status baleen whale species found in waters adjacent to NPR-A are bowhead, fin, and humpback whales. All are listed as endangered under the Endangered Species Act. Of the three, only bowhead whales occur in appreciable numbers. Fin and humpback whales are uncommon, but occasionally occur in the Chukchi Sea. There is only one record of humpback whales (Hashagen et al. 2009) and no observations of fin whales in the Beaufort Sea. Bowhead, fin, and humpback whales are migratory and do not overwinter in NPR-A waters. Bowheads may feed in large aggregations of up to hundreds of animals in nearshore waters at certain times and places.

Ice Seals

Ringed and bearded seals belong to the group known as "ice seals" that share similar characteristics, are highly dependent on sea ice for critical life functions, and their seasonal distributions and movements are heavily influenced by seasonal ice patterns in Arctic waters. Ringed and bearded seals are considered special status species although they are not currently listed under the Endangered Species Act. Both species were proposed for listing in 2010, with the projected loss of sea ice habitat as the primary cause for concern (U.S. Department of Commerce, National Oceanic and Atmospheric Administration 2010a and 2010b). Bearded seals are widely distributed across the waters adjacent to the NPR-A, with highest concentrations occurring over the continental shelf. Ringed seals can commonly be found in the shorefast ice region of the planning area from January to June. Both species occur in the vicinity of the NPR-A through much of the year, with distribution and movements closely linked to sea ice.

Polar Bear

Polar bears are a threatened species that inhabit the coastal areas of the NPR-A. Sea ice, barrier islands, and denning areas along the Alaska coast have been designated critical habitat for the polar bear. Polar bears may be present along coastal areas of the NPR-A at any time of the year, with pregnant females overwintering in shallow maternal snow dens. Proposed activities with the most potential to affect polar bears in the planning area include oil and gas exploration and development, aircraft and watercraft traffic, winter overland travel, and recreational and research activities. These activities could affect threatened polar bears by (1) causing direct mortality from defense of human life, accidental oil spills, or lethal impacts during research activities; (2) altering polar bear behavior, physiology, or movements; or (3) disturbing or destroying snow dens, which could cause impacts to cubs at critical life stages and result in mortality.

Pacific Walrus

Walrus are seasonal migrants to the Chukchi Sea where they utilize both the offshore and coastal environment of a portion of the NPR-A.

Activities Not Associated with Oil and Gas Development and Exploration

Baleen Whales

Under Alternative A, bowhead, fin, and humpback whales could be disturbed by non-oil and gas activities during migration near the coast or while feeding nearshore when barge traffic, air traffic, supply camps, or aerial surveys occur (Richardson and Malme 1993). Bowhead, fin, and humpback whales that occur in or adjacent to the planning area may react and maneuver to avoid ships, barges, and boats. In most situations, effects would likely be localized and short-term. Those individual animals disturbed would likely move away from the sound source. However, a few individual whales may be hit and injured from ship/whale collisions, but it is not expected to have population-level effects (Reeves et al. 2012). See "Oil and Gas Exploration and Development Activities" below for further details on potential effects of disturbance from aircraft and vessels.

Small fuel spills could occur in association with resource inventories and surveys, recreational activities, and overland moves. These spills would most likely involve aviation fuel and other light-fraction hydrocarbons fuels that would likely evaporate, disperse, and dilute rapidly, and would be cleaned up immediately whenever possible. These small spills would not be expected to impact marine mammals in or near the NPR-A.

Offshore scientific studies utilize aircraft, vessels, and in some cases seismic air guns to conduct research. These vessels may make stop at Barrow and Wainwright (although there are no ports) for logistical reasons such as exchange of crews and provisions. Seismic noise associated with offshore surveys (some of which may have been from research cruises) was detectable in nearshore areas in approximately 10 meters of water east of Point Barrow, (National Marine Mammal Laboratory 2009).

Ice Seals

Aircraft and vessel traffic are the non-oil and gas activities most likely to directly impact ringed and bearded seals.

Non-oil and gas aircraft include survey and research flights, recreational activities, and private bush pilot traffic. It is uncertain if seals react to the sound of aircraft or to their physical presence flying overhead. Typical reactions of hauled out pinnipeds to aircraft include looking up at the aircraft, moving on the ice or land, entering a breathing hole or crack in the ice, or entering the water. The National Marine Fisheries Service reports that 7 percent of small unidentified pinnipeds reacted to overflights above 900 feet (275 meters), but below 1,530 feet (466 meters), with only 2 percent of bearded seals reacting during Bowhead Whale Aerial Survey and Chukchi Sea Offshore Monitoring in Drilling Area flights. Flights occurred over open water, shore fast ice, and broken ice conditions (National Marine Fisheries Service unpublished data).

Seals appear to react more strongly to helicopters than to fixed wing aircraft. Blackwell et al. (2004) observed 12 ringed seals during low-altitude helicopter overflights at British Petroleum's Northstar Island in June and July 2000 (nine observations were concurrent with pile-driving activities). One seal showed no reaction, 10 reacted by looking at the helicopter and one seal left its basking site. They concluded that none of the reactions to helicopters was strong or long lasting, and that the seals near Northstar had likely habituated to industrial sounds and visible activities that frequently occurred during the preceding winter and spring. Born et al. (1999) determined that 49 percent of ringed seals left the ice in response to a helicopter flying at 492 feet (150 meters) altitude. Seals entered the water when the helicopter was 4,101 feet (1,250 meters) away if the seal was in front of the helicopter and at 1,640 feet (500 meters) away if the seal was to the side of the helicopter. They noted that more seals reacted to helicopters than to fixed-wing aircraft and concluded that the risk of scaring ringed seals by small-type helicopters could be substantially reduced if they do not approach closer than 4,921 feet (1,500 meters).

Non-oil and gas air-traffic is sparse in this area and commonly stays above this (1530 ft. or 466 m) altitude. Research and survey flights below this level are infrequent and not concentrated, and as such, would have little long-lasting disturbance to ringed and bearded seals.

Non-oil and gas-related vessel traffic authorized by this alternative within the NPR-A region would primarily be associated with survey and research activities. Vessel traffic will likely have little effect on ringed and bearded seal populations as these species show little avoidance behavior to vessel traffic. Ringed and bearded seals hauled out on ice can often be approached to within 100–200 meters by a slow-moving small boat without flushing animals into the water as long as ice is present between the boat and the animals (J. Herreman, North Slope Borough, personal observation). During open-water surveys in the Beaufort and Chukchi seas (Harris et al. 2001, Blees et al. 2010, and Funk et al. 2010) ringed and bearded seals showed slight aversions to vessel activity. Funk et al. (2010) noted among vessels operating in the Chukchi Sea where received sound levels were less than 120 decibels, 40 percent of observed seals showed no response to a vessel's presence, slightly more than 40 percent swam away from the vessel, 5 percent swam toward the vessel, and the movements of 13 percent of the seals were unidentifiable. In concurrent surveys in the Beaufort Sea, approximately 30 percent of observed seals showed no reaction to vessel activity, 50 percent looked at the vessel, and 10 percent splashed in the water.

Small fuel spills may occur in conjunction with research and inventory projects, recreation, subsistence activities, and other non-oil and gas activities. These spills would most likely involve light-fraction hydrocarbon fuels such as unleaded gasoline and aviation fuel. These fuels would evaporate and disperse rapidly and would be cleaned up immediately whenever possible as required by permit and lease stipulations. These small spills are expected to have a negligible impact to ice seals.

Ground-based activities (such as resource inventories, site cleanup, and recreation) and remote camps also create potential disturbance for ice seals. Most of these activities would likely take place during the ice-free (summer) season, and as such, would have little impact on bearded and ringed seals, which are not known to commonly haul out in large numbers on land.

Polar Bear

Winter overland travel is the non-oil and gas activity likely to have the most effect on polar bears in the planning area, due to its potential to disturb denning bears.

Non-oil and gas winter overland travel includes vehicle and sled trains used to bring supplies to villages. Winter overland travel has the potential to impact denning polar bears if it occurs within 1 mile of a denning bear. A close pass may cause abandonment of a den if it occurs early in the season but may have less significant effects later in the season (Amstrup 1993). The severity of the disturbance could range from a one-time event that might disturb an individual bear only during the passage of a vehicle to a level of disturbance that causes den abandonment, resulting in death of cubs. Vehicles traveling overland could hypothetically travel over polar bear dens, causing them to collapse and resulting in den abandonment or death of denning bears and cubs. Therefore, overland travel could cause negligible to severe impacts on individual bears. However, winter overland travel not in support of oil and gas is relatively uncommon in the planning area and likely would not result in numerous disturbance effects to the widely distributed denning bears. No population-level effects are anticipated from winter overland travel.

Aircraft (both rotary and fixed-wing) and watercraft use may be associated with a variety of non-oil and gas activities, including surveys and wildlife studies; transportation and resupply for ground-based research and management activities, such as resource inventories and paleontological research; and transportation and resupply for recreational activities. Polar bears are known to run from sources of noise and the sight of watercraft or aircraft. Denning bears may abandon or depart their dens early in response to repeated noise produced by extensive aircraft overflights or vessel traffic. Small cubs could become separated from their mothers. Non-denning polar bears would be expected to experience short-term changes in behavior as a result of non-routine traffic, such as evading a plane or boat by retreating from the stimulus. Effects would be minimal in most circumstances. Bears may swim long distances during the open-water period seeking either ice or land; and a swimming bear may become vulnerable to exhaustion and/or storms if ice floes, barrier islands, or other suitable haulouts or resting platforms are unavailable. If the presence of watercraft prevents a swimming bear from using a barrier island or other platform as a resting place, this could in rare circumstances lead to death of the bear by drowning.

Effects to non-denning bears would be minimal in most circumstances. Aircraft or watercraft traffic could be a one-time event that might disturb an individual bear only during passage; or traffic disturbance could prevent a swimming bear from using a barrier island or other platform as a resting place and cause mortality of an individual bear. Persistent traffic could cause den abandonment and the possible death of cubs. In most cases, disturbance to individual bears would be minimal and short-term (minutes to hours); however, effects on individual bears could range from negligible to severe. No population-level effects are anticipated.

Small fuel spills could occur in association with resource inventories and surveys, recreational activities, camps, and overland moves. These spills would most likely involve aviation fuel and other light-fraction hydrocarbon fuels that would evaporate and disperse rapidly and would be cleaned up immediately whenever possible, as required by permit. These small spills would not be expected to impact individual polar bears. No population-level effects are anticipated.

Ground-based activities (such as resource inventories, site cleanup, and recreation) and remote camps create potential for disturbance of polar bears and an increased risk of human-bear encounters. This is particularly the case within 1 mile of the coast, as polar bears use this area as a travel corridor. Individual bears could be repelled from or attracted to sounds, smells, or sights associated with human activities. Although most of these activities are generally short-term, localized, or transient and would result in minimal impacts to polar bears, there is some risk a negative encounter could result in the mortality of an individual bear in defense of human life. Many non-oil and gas activities would take place in summer and early fall (June to September). Observations from the oil and gas industry show increased human-bear encounter rates between August and October (U.S. Fish and Wildlife Service 2011). Non-oil and gas encounters with polar bears would thus be most likely to occur during fall, when polar bears may be found in larger numbers in the coastal environment.

Pacific Walrus

The principal non-oil and gas activities occurring in the NPR-A that could affect walrus are aircraft traffic (both rotary and fixed-wing) associated with routine transport flights, private aviation, surveys and wildlife studies; ground activities such as resource inventories, paleontological excavations, and research; and recreation camps and human foot traffic. These are activities that primarily occur in the summer and early fall (June through September) and could impact walrus if they occurred along the Chukchi Sea coast of the planning area. These activities could be either highly localized (worksite and camp) or transient (surveys and inventories), and they could cause disturbance or displacement of hauled-out walrus. The duration of disturbance could range from a single event to several days or weeks, if a camp or worksite is located immediately next to the sea coast in areas used by walrus.

If there is no sea ice in the Chukchi Sea during late summer and early fall, large numbers of walrus may be hauled out on the Alaska Chukchi Sea coast. Walrus are vulnerable to disturbance, given their tendency to aggregate in large groups. Reactions to disturbances when on ice are highly variable (Richardson et al. 1995), while reactions at group haulouts on land are more consistent. Walrus will flee haulout locations in response to visual and noise disturbance from aircraft and ship traffic. The visual acuity of walrus is thought to be less than for other species of fin-footed mammals or pinnipeds, and their hearing sensitivity is assumed to be within the 13 Hz to 1,200 Hz range of their own vocalizations. Walrus are particularly sensitive to helicopters and changes in engine noise and are more likely to stampede when aircraft turn or bank overhead. Walrus in water are believed to be more tolerant of disturbance than walrus at haulouts. Anecdotal observations by walrus hunters and researchers suggest males tend to be more tolerant of disturbance than females and individuals tend to be more tolerant than groups. Females with dependent calves are considered least tolerant of disturbances. Walrus hunters and researchers have noted walrus tend to react to the presence of humans and machines at a greater distance from upwind approaches than from downwind approaches, suggesting that odor is also a stimulus for flight response.

Severe disturbance events occasionally result in trampling injuries or cow-calf separation, both of which are potentially fatal. Calves and young animals at the perimeter of the herds appear particularly vulnerable to trampling injuries. A walrus mortality event occurred in which 131 dead juvenile walrus were discovered on the Alaska Chukchi coast south of Wainwright in September 2009 (Fischbach et al. 2009), although the events that led to the deaths of the animals are unknown. Other potential effects of disturbance on walrus include insufficient rest, increased stress, and energy expenditure, interference with feeding, masking of communication, and impaired thermoregulation of calves that spend increased time in the water. While less susceptible than calves, adult walrus also need to haul out and cannot remain at sea for long periods without rest.

While adverse impacts of disturbance on groups of hauled-out walrus can be severe, they are, to a large extent, avoidable. Local conservation partners including the North Slope Borough, Alaska Eskimo Walrus Commission, Federal Aviation Authority, and U.S. Fish and Wildlife Service recently developed voluntary guidelines regarding approach distances to minimize the potential of disturbing coastal aggregations of walrus by aircraft, marine vessels, and foot traffic (USFWS 2010). Those recommendations were utilized to develop a potential new mitigation measure (described below in section 4.3.11.4 "Potential New Mitigation Measures") for this planning effort.

Small spills could occur in association with resource surveys or inventories and recreational activities. These spills would most likely involve aviation fuel and other light hydrocarbon fuels that, if spilled, would evaporate and disperse rapidly and be cleaned up immediately whenever possible. These types of small spills would be quite limited in extent and would not be expected to reach or affect walrus in the planning area.

Oil and Gas Exploration and Development Activities

Baleen Whales

Aircraft. Potential noise disturbance to marine mammals could result from support aircraft for exploration and development. Most aircraft flights would originate from Prudhoe Bay/Deadhorse or the Alpine airfield. Some may originate from the Barrow Airport. Most flights to support exploration within the NPR-A occur during winter months; summer flights to support exploration typically are conducted in mid-July and are related to equipment maintenance over a period of 10 to 14 days (BLM 2004). Summer flights may be associated with industry studies. Limited information on the effects of aircraft on bowhead, fin, or humpback whales in the Arctic exists, however, to date no discernible long-term or chronic adverse effect linkage has been made between these species and air traffic. In places such as the west coast of North America, humpback whales are frequently exposed to low-flying aircraft with no lingering adverse effects.

Under Alternative A, aircraft associated with exploration, nearshore aerial surveys and/or logistical transit may occasionally occur over waters occupied by bowhead, fin, and humpback whales such as supply flights between Cape Simpson, Barrow, and Prudhoe Bay. Flights supporting oil and gas operations in the NPR-A could overlap bowhead whale nearshore feeding areas such as near Lonely and Cape Simpson. Fixed-wing aircraft may occur, particularly over Harrison Bay, if weather or other flight restrictions cause pilots to turn over the area to approach or leave an airstrip in northeastern NPR-A, but helicopter traffic is unlikely.

Flights in support of construction and development would include both rotary and fixed-wing aircraft, also likely originating from Deadhorse/Prudhoe, Alpine and Barrow. These flights are expected to be more numerous, particularly prior to and during construction, however, the majority of these are in support of summer field studies and are relatively short flights in the immediate vicinity of the development. Although there likely will be many flights, it is expected that primarily fixed-wing aircraft would be over the Beaufort Sea. The number of flights and duration over water would be dependent on which airport the aircraft originated from and where the airstrip they were landing was located.

Aircraft flying at altitudes greater than 1,000 feet generally do not affect bowhead whales (Patenaude et al. 2002; Richardson and Malme 1993) and are unlikely to affect fins or humpbacks. Fixed-wing aircraft flying at 500 feet (152 meters) or less altitude frequently resulted in rapid diving of overflown bowheads. Repeated low-altitude overflights at 500 feet during aerial photogrammetry studies of feeding bowheads sometimes caused abrupt turns and quick dives (Richardson and Malme 1993). A study of bowhead reactions to experimental Twin Otter aircraft overflights during spring migration through the lead system found that aircraft elevation and altitude influence reaction rates. Very few whales reacted to any overflights, but of those that did, most reacted to aircraft less than 600 feet (182 meters) in elevation and 820 feet (248 meters) lateral distance from the whales (Patenaude et al. 2002).

The lack of an overt response from aircraft should not be interpreted as the lack of an effect. Unnoticed changes in behavior such as cessation of feeding or other behaviors may have occurred. However, it is unlikely that the relative effect rose to a level that would affect the fitness of the animal or cause a population level effect. Repeated low-level overflights may cause sufficient disturbance to produce an impact. The expected low number of flights that would occur over areas used by bowheads, the low number of bowheads likely to occur in areas potentially overflown, and that normal operating elevations are high enough that little effect would be predicted by available information suggest that aircraft activity under Alternative A is unlikely to impact bowhead whales. Humpback and fin whales are quite rare in the nearshore Beaufort and Chukchi Seas, so impacts from aircraft on these species are expected to be very limited.

Seismic Activities. Onshore seismic surveys would not be expected to have any impacts on marine mammal species because none of the marine mammals addressed here occur onshore during the winter when seismic would occur.

Seismic activity may occur in small areas offshore of Atigaru Point area inside the barrier islands, Elson Lagoon, Dease Inlet, and Wainwright Inlet. It is expected that any seismic activity would be done over ice; therefore, impacts to bowhead, fin, and humpback whales, which by then would have left arctic waters, would not occur.

Shipping. Bowheads exhibit strong and consistent avoidance behavior if approached directly by vessels reacting to ships at 2.5 miles (4.2 kilometers) or greater (Richardson et al. 1995). Avoidance behavior appears to be generally temporary but may displace whales by several miles. Research to determine if individual short-term displacement from ship traffic has a significant effect on individuals has not been conducted, however National Marine Fisheries Service has stated any effects are negligible and do not affect the bowhead, fin, or humpback stocks. Furthermore, fin and humpback whale presence in the Chukchi and Beaufort seas are believed to be so few that numerically the potential impacts would affect so few individuals, the stocks would remain unaffected (National Marine Fisheries Service 2008). Bowhead stocks have continued increasing at such a rate that their numbers are approaching pre-commercial harvest levels, consequently, it is logical to conclude existing levels of shipping in the Beaufort and Chukchi seas has not had an effect sufficient to adversely affect the greater population.

Noise-producing marine vessel and aircraft traffic would be the most probable source of disturbance to bowhead whales under this alternative. Bowhead whales could encounter a few vessels associated with oil and gas activities in the planning area during their fall migration through the Beaufort Sea. Although most of the vessel activity would be in shallow nearshore waters from Harrison Bay to the Kuk River near Wainwright, these waters are, at times, traversed by feeding and migrating bowhead whales (Tracey 2002; Clarke et al. 2011). While specific studies on the long-term impacts of shipping on bowhead whales have not been conducted, there is a large body of research on the reactions of these whales to vessels. These effects would likely be localized and short-term. Whalers in Barrow perceived that bowhead whales migrated farther from shore in 2003 than in other years, and hypothesized that the deflection resulted from vessel operations at Lonely, within the northeast NPR-A and caused "skittish" behaviors (Bureau of Ocean Energy Management 2011).

Bowheads shift between inner shelf and coastal waters and outer-shelf and slope waters during fall migration, apparently dependent on ice characteristics and its relationship to prey density (Moore 2000). However, in recent surveys during light ice years, bowheads were significantly closer to shore (Clarke et al. 2011). If vessel traffic caused whales to move offshore away from high-density forage areas in the western Beaufort or Chukchi seas, it could cause reduced fitness. Few data are available to determine the extent or duration of displacement (although feeding bowheads may return to use areas after disturbance) (Richardson et al. 1995), there are no clear data to indicate migrating whales return to their previous bathymetric course. Therefore, at least some displaced whales would be expected to return to normal (for the ice conditions) migration routes after clearing the disturbance zone of the vessel (possibly 2.5 miles or more), and some most likely would not.

Most boat traffic associated with exploration and development within the planning area is expected to be either multi-vessel sealifts to support construction or single transport vessel for annual re-supply or transport of equipment. Some small vessel traffic may also occur for oil spill response practice.

Sealifts and regular support shipping typically take place in late July through September to take advantage of the reduced ice and to avoid conflict with subsistence whaling. Sea lifts to support construction would likely come ashore along the northern coast of the NPR-A, and material would be stored at a staging area (e.g., Lonely, Cape Simpson, Barrow, and Wainwright) until ice roads could be constructed and the material then would be moved overland to the construction site. After initial construction, barges may also be used to resupply oil and gas developments. Much of that material may come ashore at the Prudhoe area (and to a lesser extent Cape Simpson) where facilities for storage exist and be transported overland or by air, with only heavier equipment landed in the NPR-A.

Bowhead, fin, and humpback whales that occur in or adjacent to the planning area may react and maneuver to avoid ships, barges and boats. However, the distance at which they react is dependent on the species, individual, activity/season, type size and behavior of boat, and physical conditions (review in Richardson et al. 1995). The duration and severity of the avoidance behavior also seems to vary, with some evidence that whales actively avoid shipping lanes and other reports of possible habituation (Moore and Clarke 2002).

Vessel traffic associated with exploration and development may encounter multiple individuals of several species of marine mammals. Encounter times would be relatively short, and individuals would likely encounter the vessel once in any period, possibly twice as vessels would be traveling point to point, unlike survey ships or seismic vessels. Shipping activity would take place after calving/birthing periods and when animals are typically well distributed foraging, or possibly during the beginning of early fall migration. Bowheads are expected to have short-term, short distance avoidance behaviors, which may reduce feeding opportunities, but are not expected to result in abandonment of foraging areas, or measurable declines in body condition as a result (Richardson et al. 1995). Fin and humpback whales are virtually absent from the Beaufort Sea and uncommon in the Chukchi Sea, so interactions with vessels will likely be infrequent and disturbance effects minimal.

If shipping noise caused fall migrating bowhead whales to deflect oceanward and bypass high-density feeding areas, some effects to whale fitness may occur. Given the short duration and limited number of disturbance events likely resulting from exploration or development in the planning area, the effects are not expected to result in reduced reproductive rates, and direct mortality would be rare (George et al. 1994). Potential impacts of vessel collisions are discussed below.

Contaminant Spills. A detailed discussion of the potential effects of oil on whales can be found in the Beaufort Sea Planning Area Oil and Gas Lease Sale 186, 195, and 202: Final EIS (USDOI MMS, 2003d), pages IV-73-IV -77. This document and the subsequent Biological Evaluation for the Chukchi and Beaufort Sea OCS Leases (USDOI MMS, 2006f) document the uncertainty regarding effects of oil on bowhead and the difficulty in applying information from other species. Minerals Management Service (2003d) suggests that oil may act on bowhead whales through oiling the skin, inhalation, ingestion, baleen fouling, reduced prey and displacement from feeding areas, and death. In examining the available information, Minerals Management Service found that support for and against such effects occurring were equivocal. Minerals Management Service concluded in their Biological Evaluation that most adult whales exposed to spilled oil would suffer temporary or permanent non-lethal effects, but that prolonged exposure to freshly spilled oil could result in death (USDOI MMS, 2006f, p 87). Impacts to newborn and very young calves may be greater. Albert (1981) speculated a number of sub-lethal effects from oil contact to bowheads including exacerbation of normal skin lesions, compromising of tactile hairs, obstruction of the "connecting channel" of the stomach, irritation of the eye, and other effects. Oil that has been suspended in the water column or in the sediment could be directly or indirectly (through prey) consumed by baleen whales. This could result in long-term exposure to hydrocarbons through prey, which could lead to bioaccumulation of toxins. Spill containment and cleanup, if they were to occur outside of the shallow nearshore habitat during the westward migration in autumn, may affect migrating bowhead whales by causing deflection and avoidance of the area. Any offshore displacement effect, however, is likely outweighed by the reduced potential to come in contact with spilled oil.

An oil spill resulting from development under Alternative A would be unlikely to occur in the marine environment, or to reach typical baleen whale migration or feeding habitat from onshore locations. Small spills would be unlikely to reach marine habitats, and thus, would have a low probability of affecting bowhead, fin, or humpback whales.

Effects of a Fuel Spill Associated with Barging. It is possible that a contaminant spill could result from barge traffic (i.e., a sinking or holing of the tug or fuel tank(s) of a self-propelled barge). To date there is no record of such spills associated with barging in support of oil and gas development and exploration and such a spill is considered unlikely. However, a spill associated with Navy supply operations occurred in NPR-A waters in 1944. Thomas Brower, Sr., described a 25,000-gallon (595- barrel) oil spill in Elson Lagoon along the Plover Islands in 1944 (Brower 1980). He noted that it took approximately 4 years for the oil to disappear and that, during that time, bowhead whales that normally migrate close to the islands made a wide detour out to sea during fall migration when passing near Elson Lagoon/Plover Islands (Brower 1980). This suggests that, at least in the case of bowhead whales, displacement can last for several years and that bowhead whales may be able to detect an oil spill and avoid surfacing in it by detouring around the area of the spill (Minerals Management Service 2008).

Summer and autumn storms may also be a risk to barging operations. A North Slope Borough dredge barge was sunk off Barrow in a powerful storm in August 2000. Also, in the 1960s a powerful storm drove at least three fuel barges ashore on Tapkaluk, Martin, and Igalik Island east of Barrow. At least two of these barges remain visible on Martin and Igalik Island. A century earlier, rapidly advancing heavy sea ice resulted in the destruction of many (over 50) Yankee whaling vessels along the NPR-A Chukchi Sea coast (Bockstoce 1986), but vessels now rarely become ice-entrapped.

Any such spill could potentially affect marine mammals. A spill that occurred in summer or fall during the shipping season could affect any marine mammal species that occurs in the Beaufort or Chukchi seas adjacent to the NPR-A. Such a spill may result in lethal or sublethal effects on special status whales. The actual number of animals affected would be dependent on the volume of spill, the weather, location, and the success of cleanup efforts.

Vessel Collisions. Vessels may strike and injure or kill marine mammals (Laist et al. 2001), and are the main source of anthropogenic mortality preventing the North Atlantic right whale from recovering (Kraus 1990). Direct collisions have resulted in mortality and injury to whale species. Contact with the propeller(s) and direct collisions are known to injure bowhead whales and other large marine mammals (George et al. 1994; review in Laist et al. 2001).

While all sizes of vessels have been involved in collisions with whales, vessel size and speed are factors in determining whether a collision results in severe injury or death. Ships over 260 feet long are more likely to cause severe injury or death when vessels are traveling over 14 knots (16 mph) (Laist et al. 2001) and drops markedly below 11.8 knots (Reeves et al. 2012). (Laist et al. 2001) Barges transiting the Beaufort and Chukchi seas usually travel at 6–7 knots (7–8 mph) (Reeves et al. 2012) or half the speed associated with most severe injury or mortality. Total length of barge and towing vessels may be greater than 260 feet, but it is not known if they are equally likely as a self-contained vessel to cause severe injury in a collision.

Any increase in shipping traffic related to development in the NPR-A could increase the potential for collisions with bowhead whales. Alternative A could result in higher levels of periodic barge traffic over approximately 50 years in addition to the existing levels of shipping to support other development in Prudhoe Bay and North Slope villages. The only study specifically dealing with collisions and bowhead whales was conducted by George et al. (1994). They found that approximately 1 percent of whales harvested off Barrow had scarring consistent with contact with propellers of large ships (George et al. 1994). Where these collisions occurred within their range is unknown. The 1 percent estimate is likely biased low as whales killed by collisions were not available for harvest and sample size was relatively small compared to the population. In a more recent preliminary analysis, Reeves et al. (2012) used both known and suspected ship injuries and estimated 2–3 percent of landed whales showed evidence of ship or propeller injuries. Some evidence is provided by Laist et al. (2001) that the number of whale strikes has increased as the number of ships increased worldwide, suggesting that an increase in shipping traffic could result in increased strikes (Laist et al. 2001). Reeves et al. (2012) specifically address the possibility of ship strikes on bowheads based on long-term studies of North Atlantic Right Whales. They note “vessel strikes are the most significant known cause of mortality in North Atlantic Right Whales” and suggest that for the closely related bowhead whale “increased maritime ship traffic and commercial fishing in the Arctic are bound to affect bowheads.”

George et al. (1994) concluded that ship-caused mortality was not sufficient to interfere with growth of the western Arctic stock as evidenced by the relatively strong annual rate of increase in population size of western arctic bowhead whales (George et al. 2004). However, it should be noted that the actual total vessel traffic in the Beaufort or the rest of the western Arctic stock range is unknown and may have increased in the last decade with some increase in mortality. If so, the mortality is likely low as the population continues to increase (George et al. 2004). Shipping noise may also induce “skittish” behavior in bowheads as observed by Alaskan Native hunters, whereby they become shy and evasive (Bureau of Ocean Energy Management 2011). Such behavior would reduce ship-whale interactions.

Fin and humpback whales are susceptible to ship strikes in other seas (Allen and Angliss 2011). Collisions between cruise ships and humpback whales have been documented in southeast Alaska and identified as known sources of anthropogenic mortality (Gabriele et al. 2007). While humpback and fin whale numbers in NPR-A waters are low, they may continue to increase, which suggests that collisions are at least a limited possibility.

Development and Production. Presumably, once production is under way, shipping and barge activity, considered to be the main impact on protected whales, would decrease from levels during construction and reduce impacts. However, to the extent that development in the NPR-A is not linked by a road to the Dalton Highway, barging will remain the main mode of transportation for resupply and oil field equipment.

Ice Seals

Seismic Activities. Onshore seismic surveys are not expected to impact seal species since the species do not occur onshore during the winter when seismic would occur.

Disturbance from off-shore seismic surveys including shallow hazard/site clearance surveys that commonly use air gun arrays, on-ice vibroseis surveys, and ocean-bottom cable surveys used in exploration activities are of concern for seals. Seismic surveys using large towed marine-streamer air gun arrays typically occur in deeper offshore waters and would not occur in association with NPR-A activities. Vibroseis surveys occur in nearshore areas on thickened sea ice capable of supporting the equipment during the winter months. Ocean-bottom cable surveys are conducted during open water in nearshore shallow water zones. This type of seismic survey is used to acquire seismic data in water that is too shallow for large marine-streamer vessels and/or too deep to have grounded ice in the winter. As noted in section 4.3.10, seals show little adverse effects to seismic surveys in open water, and as such, ringed and bearded seals are not likely to be adversely affected by this type of operation.

On-ice surveys (vibroseis) are typically conducted only in the shallower, nearshore waters and take place during the winter months. Ringed seals are the only species likely to be in these areas during this time, although bearded seals may also be present in deeper waters farther offshore. At this time of year, ringed seals excavate a series of subnivean lairs accessed from holes they maintain in the ice from below, for pupping and to provide protection from predators (section 3.3.7 in Volume 1). Ringed seals use multiple breathing holes and are not expected to be adversely affected by the loss of one to two breathing holes from activities such as the creation of a thickened ice road. Ringed seals near British Petroleum's Northstar Island appear to have the ability to open new holes and create new structures throughout the winter, and ringed seal use of landfast ice near Northstar did not appear to be much different than that of ice 1.2 to 2.2 miles away (2 to 3.5 kilometers; Williams et al. 2002). Vibroseis surveys involve a number of heavy tracked vehicles. Survey vehicles with vibrators and sensors are often deployed in shallow water areas and may disturb seals in their subnivean lairs or animals hauled out on top of the ice. Standard mitigation measures required by the National Marine Fisheries Service include advance scouting of routes and survey lines to minimize impacts to seals by avoiding areas more likely to have lairs (pressure ridges and deep snow accumulations). These mitigation measures also require use of various methods to detect and avoid seal lairs, thereby, greatly reducing the chance of destroying an active lair from ice road construction or on-ice survey activities. If an active lair is not detected and is incidentally impacted by heavy survey equipment, the adult female would likely escape into the water but the pup could be killed by crushing or premature exposure to the water. Disturbed adults may remain in their lairs, move to other nearby lairs, or swim to different breathing holes (Kelly et al. 1988). Because the survey vehicles move to new locations every few minutes, the disturbance is temporary in nature and unlikely to drive animals out of their normal territory.

Potential impacts to hearing (temporary threshold shift and permanent threshold shift) of seals by seismic activity are described in section 4.3.10. As noted, there are few data or studies available on sound levels and durations required to elicit temporary or permanent threshold shift in seals. The potential for disturbance and hearing damage does exist if a seal should be present in the ensonified zone. Seals could avoid the sound by leaving the area or remaining at the surface with their heads out of the water. Seismic source sounds also have the potential to affect seals by disrupting or masking vocal communications. If sound produced by vibroseis operations propagates offshore where bearded seals primarily occur, masking of bearded seal vocalizations could result. Bearded seals are known to be a highly vocal species (Cameron et al. 2010) and it has been suggested that these vocalizations are related to the establishment of territories and mating. Ringed seals are also known to establish territories (Kelly et al. 2008, Kelly et al. 2010), but it is unknown what role sounds play. Concentrated seismic activity over sea ice for long durations during the establishment of territories and mating seasons could have a detrimental impact on some individuals of both species.

Prey of ringed and bearded seals (various fish, shrimp, crustaceans, benthic invertebrates, amphipods: see section 3.3.8.4) could be affected by marine seismic surveys. The effects of seismic surveys on fish are described in section 4.3.7.2. Adult fish are most likely to temporarily flee loud sound sources, although egg and larvae may be vulnerable to loud sound at close range. Studies of the impacts of vibroseis on fish indicate that avoidance behavior is the most likely reaction; there was no indication of physical injury or mortality. Multiple exposures, however, could be of concern. Given the diversity of prey consumed, and the wide distribution and dynamic nature of prey fields for ringed and bearded seals, these species are unlikely to experience any lasting changes to their foraging success as a result of seismic surveys.

Under Alternative A, oil and gas development actions would be deferred from the coastal area of the 2014 deferral area in northwest NPR-A, and the 2018 deferral area in northeast NPR-A (Maps 2-1 and 2-1T). After 2014, the Kasegaluk Lagoon Special Area would be managed to receive maximum protection for marine mammal values, consistent with exploration of the Reserve. While this would encourage protection for seals, it would not necessarily preclude the above noted effects from occurring. These provisions still leave a large portion of ringed seal habitat unprotected from disturbance in the major nearshore waterbodies and protections in the deferred areas are void after the above-listed dates. Disturbances, destruction of lairs, and loss of young are less likely to occur east of Pitt Point where nearshore water depths are less than 10 meters and ringed seal densities decrease (Moulton et al. 2005). West of Pitt Point, however, the probability of destroying subnivean lairs is high if sight clearance surveys are not conducted to avoid lairs.

Drilling and Production. Drilling and production operations involve the establishment of a drilling and production platform and the deployment of numerous support vessels or vehicles. Onshore drilling and production are highly unlikely to have negative impacts upon ice seals due to the lack of seals onshore. Offshore drilling and production, however, are of concern. The level of disturbance to seals is likely more intense in terms of the physical presence of the platforms compared to other types of actions, but the geographic area involved is much smaller. The noise generated from drilling is also not as loud as seismic air guns, but it is produced on an almost continual basis, making it more of a chronic sound source in one general location. Given the mild reaction of seals to marine vessels, drilling activities could deter seals from venturing too close to the rig and support vessels while it is in that particular area. This displacement would cover a very small area. Moulton et al. (2003), however, found no significant change in ringed seal densities near the Northstar drilling platform during construction and operation compared to prior densities. Bearded seals do not generally establish territories in the nearshore environment, but rather are primarily a pack ice species; using nearshore areas on a transient basis (see section 3.3.7 in Volume 1). As such, drilling operations likely would have little negative impact on bearded and ringed seals.

Travel and Shipping. Seals in general show little negative response to vessel traffic in open-water conditions with the exception of traffic close to terrestrial seal haulouts. As such, marine traffic is unlikely to have adverse effects on ringed and bearded seals as they do not commonly use terrestrial haulouts. Air traffic would have similar effects as those listed in section 4.3.10. The major difference is the possibility of increased air traffic along specific corridors to production and drill facilities. This traffic could have small adverse effects of displacing or disturbing a minimal number of animals along these corridors. Moulton et al. (2003), however, found no effects to ringed seal densities due to production activities, which would include travel to and from sites. Travel during the shorefast ice season would presumably follow designated surveyed corridors, and as such, would have little effect on ringed seal subnivean lairs. Travel that does not follow established surveyed corridors such as initial seismic work and travel corridor surveying has the possibility to crush subnivean layers and kill young pups. Site-clearing surveys should be conducted to avoid such incidents. Under Alternative A's Required Operating Procedure C-1, cross-country use of heavy equipment and seismic activities is prohibited within 1 mile of known or observed seal-birthing lairs. Operators are required to consult with the National Oceanic and Atmospheric Administration Fisheries, as appropriate, before initiating activities in coastal habitat between October 30 and April 15.

Contaminant Spills and Discharge. Small contaminant spills are unlikely to have significant detrimental impacts to ringed and bearded seal populations with the exception that numerous small spills over time could have an impact if a small number of animals were regularly to come in contact with each spill. A large or very large contaminant spill that reaches marine waters, however, could have detrimental effects on ringed and bearded seals similar to those noted for other seals. Controlled studies by Smith and Geraci (1975) found ringed seals may develop mild liver damage, kidney lesions, and some eye damage from immersion in crude oil. Eye damage was often severe, suggesting permanent damage might occur with longer periods of exposure to crude oil; the overall severity of the injuries was most likely associated with the duration of exposure. Ringed seals in oil exposure experiments were able to process and excrete at least some of the ingested hydrocarbons (Engelhardt 1978; 1982; 1985; Engelhardt et al. 1977). These limited studies show that seals may tolerate small amounts of ingested oil. Effects from chronic ingestion of oil would require long-term studies. Although the seals studied converted hydrocarbons into metabolites that were excreted in urine, some hydrocarbons were still deposited in lipid-rich tissue, like blubber (St. Aubin 1990). It is not known if hydrocarbons accumulate with repeated exposure, but residues deposited in fat could be released into the body when fat stores are mobilized during molt or reproduction, or transferred to nursing pups through milk. Incidental ingestion may not cause great distress, but pinnipeds trapped in or near a large spill or forced to emerge through heavy oil could suffer the more severe effects (St. Aubin 1990). The extent of impacts would depend upon the type and amount of materials spilled, location of the spill, spill rate, time of year, weather conditions, and effectiveness of the response.

Both ringed and bearded seals use nearshore areas throughout the year, including large freshwaterbodies connected to the marine environment. Therefore, individuals of both species could potentially be exposed to any contaminant that enters connected freshwater systems. However, more seals may be exposed through marine water contamination, due to the higher use of marine habitats relative to freshwater habitats.

The potential for a spill to occur directly into the marine environment is reduced by the leasing deferrals (while they are in place), as well as Stipulations K-3b and K-8b. After the western deferral is lifted from the Kasegaluk Lagoon area, the K-8b stipulation would prohibit permanent oil and gas facilities there (such as wellheads). Stipulation K-3b would seasonally (May 15-October 15) prohibit exploratory drilling in Dease Inlet, Admiralty Bay, and Elson Lagoon and associated islands, and prohibit wellheads and most other permanent development facilities from being placed on the seaward side of the coast in these areas, up to three-quarter mile out. However, Alternative A would allow pipelines in those waterbodies, and other permanent facilities beyond the three-quarter mile buffer, limiting potential for spill avoidance.

These stipulations, combined with the temporary deferrals and numerous required operating procedures designed to prevent and handle spills (e.g., A-3 through A-6), would minimize the risk that large numbers of seals would come into contact with contaminant spills.

While stipulations K1, K3b, and K6 and make it highly unlikely that large quantities of oil would reach marine waters, in the event that it did, substantial levels of mortality for both species could occur if animals could not quickly relocate to uncontaminated waters. Food resources could also be affected in localized regions of impacts, and result in reduced survival and recruitment. Oil suspended in the water column or in the sediment could be directly or indirectly (through prey) consumed by ice seals. This could result in long-term exposure to hydrocarbons through prey. Refer also to 4.12.4.10 in Volume 4 for a description of potential impacts from a low-probability very large oil spill.

Effluent discharge from marine vessels supporting drilling and production operations is also of concern for ringed and bearded seals. As noted in section 4.3.10, such discharge could have detrimental effects on seal species. Alternative A, Required Operating Procedures A-2, A-6, and A-7 will ensure that discharge is unlikely to occur at development and production facilities; however, with the minor exception of Required Operating Procedure A-2d, they do not regulate discharge of supporting vessel traffic.

Effects of Abandonment and Reclamation. Effects of abandonment and reclamation would be similar to those found under development and production. The greatest concerns for ringed and bearded seals would be the destruction of ringed seal subnivean lairs, the disruption of vocal communications, the potential for large oil spills, and possible introduction of new biota to the system from discharges related to shipping.

Polar Bear

Polar bears and their designated critical habitat are protected from significant impacts caused by industrial activities through the BLM leasing stipulations and required operating procedures, as well as subsequent endangered species consultations. The portions of polar bear critical habitat contained within the boundaries of the NPR-A are shown on Map 3.3.8-6 (the shaded area 5 miles inland from the coast, and barrier islands).

Seismic Activities. Under Alternative A, seismic surveys conducted near the coast could expose undetected denning polar bears to noise and associated disturbances. Although a relatively low number of polar bear maternal dens have been recorded in the planning area (Map 3.3.8-6), dens could occur anywhere within approximately 5 miles of the coast. Seismic disturbance could result in the displacement of maternal polar bears and their dependent cubs, abandonment of the den, and possible death of polar bear cubs. Required Operating Procedure C-1 prohibits cross-country use of heavy equipment and seismic activities within 1 mile of known polar bear dens and requires operators to consult with the U.S. Fish and Wildlife Service before initiating activities in coastal habitat between October 30 and April 15. Depending on the suitability of the area for polar bear dens, the operator may also be required to survey for dens prior to seismic activities. This combination of procedures minimizes the chance that denning polar bears would be disturbed by seismic activities. Impacts to individual female polar bears and cubs would only occur in the unlikely instance that a den would go undetected during a survey. No population-level impacts are anticipated.

Exploration. Under Alternative A, few coastal areas would be immediately open for exploration; but upon expiration of the deferral areas, more coastal areas would become available. It is estimated there could be up to 60 oil exploration and delineation wells and 136 gas exploration and delineation wells drilled under Alternative A. These wells are expected to be drilled from ice pads, causing short-term ground disturbance of 360 and 816 acres, respectively. The actual number of wells with potential to affect polar bears is not currently known. Although polar bears may be found up to 25 miles from the coast, dens tend to be located within 5 miles of the coast. Because exploratory drilling would be a winter activity, the primary threats to polar bears would be disturbance to females in maternal dens and attraction of non-denning bears to drilling support facilities.

Exploratory drilling near the coast during winter (December to mid-April) would potentially disturb, displace, or attract polar bears. Disturbance of females in maternity dens could result in premature exposure or abandonment of the cubs (Amstrup 1993). MacGillivary et al. (2003) measured noise from industrial activities in the air and within artificial polar bear dens at varying distances from the activities. Noise within the dens from vehicle traffic was generally attenuated to background levels when vehicles were about 1,600 feet away.

Conservation measures have been established to protect female polar bears denning within 1 mile of construction activity. Required Operating Procedure C-1 requires all industrial activities maintain a 1-mile buffer around known or suspected polar bear dens. In addition, oil and gas exploration activities within polar bear habitat require coordination by the operator with the U.S. Fish and Wildlife Service, so that any potential polar bear dens can be located prior to winter exploration activities.

Activities at industrial facilities, particularly within 1 mile of the coast where most bears are observed, may cause individual bears to alter travel routes to avoid contact with facilities. Bears may also avoid denning, hunting, and resting near structures. Alternatively, facilities supporting exploration activities that are up to 25 miles inland could attract non-denning polar bears and result in the need to implement deterrence measures for human safety reasons. Bears could habituate to human food or garbage or utilize facilities for shelter, increasing their potential to encounter humans. Required Operating Procedures A-1 and A-2, which require proper waste prevention, handling, and disposal, should be effective in preventing or minimizing attraction of polar bears. Required Operating Procedure A-8, requiring implementation of a bear interaction plan, would reduce the likelihood of negative human-bear encounters. These plans include measures to minimize attraction of bears to industrial facilities, methods for communicating to workers about bears in the area, and an outline of proper procedures to follow in the event that bears are observed near industrial facilities and work sites. Lessees would be required to keep a systematic record of bears onsite and in the immediate area, which could be used to inform future stipulations and policies intended to minimize human-bear conflicts. Such requirements for facility management and human-bear interaction plans have been successfully implemented at oil and gas exploration and production facilities in other portions of the North Slope. It is anticipated that impacts to polar bears attracted to exploration activities in the planning area would also be minimized and actively managed to promote human safety, while limiting detrimental effects to the bears.

Development and Production. Under Alternative A, few coastal areas would be immediately open for oil and gas leasing; but upon the expiration of deferrals, more coastal areas would become available. Surface disturbances would include gravel production pads and central processing facilities for oil and gas, gravel roads, gravel runways, and several types of pipelines (some of which may be buried). Under Alternative A, the long-term disturbance footprint would be 9,902 acres. The number of development and production facilities (and corresponding gravel footprint) with potential to affect polar bears is unknown at present. Only facilities within 25 miles of the coast have a likelihood of directly affecting polar bears, and facilities within 5 miles of the coast could affect maternal dens.

Impacts to polar bears, including disturbance, caused by development and production activities would be similar to those discussed above for aircraft and watercraft traffic and exploration activities. There is the potential for winter activities to disturb maternal polar bear dens and for non-denning bears to avoid or be attracted to human facilities. The new gravel pads and elevations they provide may create features that cause snowdrifts, which may provide denning habitat within the industrial infrastructure. There is some chance that oil and gas transportation networks would act as physical barriers to the movements of polar bears. However, polar bears have frequently been observed crossing existing roads and causeways in the Prudhoe Bay oilfields. Impacts to polar bears from the transportation network infrastructure would be expected to be minimal.

The same avoidance and mitigation measures that would be employed during seismic activities and exploration would be utilized during development and production, including avoiding denning polar bears by 1 mile, minimizing polar bear attraction to facilities, developing human-bear interaction plans, and implementing training for facility personnel. Additionally, Best Management Practice E-5 would require that facilities be designed and constructed to minimize impacts of the development footprint, using techniques such as directional drilling and collocation. Reduction in the potential footprint within coastal areas would confer some benefits to polar bears. Best Management Practice E-4 would require sound pipeline construction to minimize leaks and thus helps minimize take of listed species.

Oil Spills and Gas Releases. Alternative A poses some risk of small and large spills of oil, refined fuel, and produced water and potential for gas releases. These events could happen at any time of the year. Polar bears could come into contact with unrecovered oil on land, on ice, or at sea. The results to the physical health of the bear would be the same. If polar bears avoided coastal areas that were fouled by oil, or were displaced by response activities, they may be excluded from feeding, resting, or denning areas, which could impact body condition, breeding success, or survival.

In addition to their layer of fat, polar bears rely on their fur for insulation, and oiling would cause the fur to lose its insulating ability. Hurst and Oritsland (1982) found polar bear pelts were similar to those of sea otters and fur seals in terms of the loss of insulation once oiled. Oiling could lead to hypothermia and result in increased energy costs to maintain body temperature or death. Oiled polar bears could ingest oil by grooming and could also ingest oil by eating oiled seals or carcasses. Experiments in which polar bears were made to ingest crude oil have demonstrated that crude oil is highly toxic to polar bears, and it has been demonstrated that polar bears may be affected by direct contact with spilled oil or ingestion of contaminated prey (Oritsland et al. 1981; Stirling 1990). Exposure to oil or associated fumes could cause respiratory distress and inflammation of mucous membranes and eyes, leading to abrasions and ulcerations. Even partial oiling of a polar bear is likely to result in mortality, while chronic, low levels of exposure could result in sublethal effects that reduce health or reproduction.

The likelihood of a polar bear coming into contact with a small spill at any given time is low. There would be spill containment and response plans in place at all facilities, and it would likely be possible to deter an individual bear from a small spill. The effects of a small spill would be short-term (days to weeks), localized, and at most should affect very low numbers of individuals.

The risk of large spills under each alternative is based on the volume of oil expected to be produced over the life of the oil exploration and development that might proceed from leasing and discoveries in the NPR-A. For Alternative A, the percent chance of one large spill occurring is 37 percent. The risk of a large spill is higher under Alternative A than under Alternatives B-1 and B-2, the same as Alternative C, and slightly lower than Alternative D. For all alternatives, the extent of impacts from a large oil spill would depend on the size, location, and timing of spills relative to polar bear distribution and on the effectiveness of spill response and cleanup. In certain areas, polar bears congregate at whale bone piles (e.g., Point Barrow, Cross Island, and Kaktovik). More than 60 polar bears have been observed feeding on whale carcasses outside of Kaktovik (Miller 2006). However, none of these aggregation areas are within the planning area; and in most other areas, polar bears are widely dispersed (Amstrup 1986, Amstrup et al. 2000). In the event of a large oil spill, it is most likely that tens to dozens of polar bears would be directly affected through oiling. Depending on the age and sex of oiled polar bears, a population-level effect may occur if a spill were to contact an aggregation of bears.

Response activities associated with a large spill also have the potential to disturb or affect polar bears; displace them from feeding, resting and denning areas; and potentially contaminate their food chain.

There is small potential that a large gas release could occur from a platform, pipeline, or onshore facility. Direct impacts to polar bears as a result of a gas release would be minimal because gas would quickly dissipate. Although a bear in the immediate vicinity could potentially experience impacts from inhaling gas, or be injured or killed if an explosion occurred with the release, these scenarios are unlikely. Impacts to polar bears may occur as a result of response activities. If disturbance caused polar bears to be excluded from feeding, resting, or denning areas, this could impact body condition, breeding success, or survival.

Effects of Abandonment and Reclamation. Effects of abandonment and reclamation would generally be similar to those under construction (during both exploration and development and production phases). Human activities, particularly visual and noise components, could disturb individual polar bears, including both denning and non-denning bears. Disturbing known denning polar bears would be avoided, as during construction activities. No population-level effect would be expected.

Pacific Walrus

Oil and gas development activities that have the most potential to affect walrus include aircraft traffic, watercraft and shipping traffic, and oil spills.

Operating equipment such as supply boats, fixed-wing aircraft, and helicopters near walrus without the use of appropriate mitigation measures could result in disturbances through visual or noise stimuli. Potential effects of disturbance on walrus include insufficient rest, increased stress and energy expenditure, interference with feeding, masking of communication, and impaired thermoregulation of calves that spend an increased amount of time in the water. Prolonged or repeated disturbances could potentially displace individuals or herds from preferred feeding or resting areas. Disturbance events could cause walrus groups to abandon land or ice haulouts. Severe disturbance events could result in trampling injuries or cow-calf separations, both of which are potentially fatal. Calves and young animals at the perimeter of the herd appear particularly vulnerable to trampling injuries. The response of walrus to disturbance stimuli is highly variable. Individuals tend to be more tolerant than groups. Females with dependent young are considered least tolerant of disturbance.

Coastal aircraft and watercraft traffic (including barges) that would support construction and oil and gas operations have the potential to disturb walrus in the ocean, on sea ice, or hauled out onshore. Overall, the potential exists for aircraft and watercraft to cause serious adverse effects to individuals or groups of walrus due to disturbance.

Walrus could be directly and indirectly affected by a large oil spill. Exposure to oil or associated fumes could cause respiratory distress and inflammation of mucous membranes and eyes, leading to abrasions and ulcerations. Walrus would be particularly vulnerable because of their large, protruding eyes. Walrus rely primarily on a thick layer of blubber for insulation and are less likely than furbearers to suffer hypothermia as a result of oiling. However, they may be more likely to suffer skin inflammation and ulcers as a result of oil exposure. Studies have shown that while marine mammals such as walrus are not usually directly killed by contact with oil, ingestion of oil or oil-contaminated prey items can cause tissue changes with sublethal effects (Kooyman et al. 1976). Walrus could come into contact with oil at sea or at haulouts. Regardless of whether contacted at sea, on ice, or on land, the results to the physical health of walrus would be detrimental. Because walrus tend to aggregate, there is potential for relatively large numbers of walrus–potentially hundreds of individuals–to be oiled if a large oil spill were to enter the Chukchi Sea. It may be possible to haze or deter walrus; but if they are oiled, direct and indirect effects on females and juveniles that utilize the Chukchi Sea could result in population-level effects.

Oil spill response activities would be complicated by the presence of walrus in the vicinity of a marine oil spill. Due to their sensitivity to aircraft and marine vessel traffic, walrus in the vicinity of an oil spill would likely be disturbed by response activities. A marine oil spill response has the potential to displace (either intentionally by hazing, or unintentionally from vessel, aircraft, and land-based traffic) walrus from foraging areas or from their preferred coastal haulout areas. Disturbance to large numbers of walrus at haulouts could result in a stampede to open water. A stampede could, as previously discussed, lead to a walrus mortality event, or walrus could be displaced from shore into areas of the oil spill.

Because natural weathering of oil is very slow in arctic waters, it is anticipated that oil that has been suspended in the water column or that has settled on sediment will be ingested by the benthic organisms walrus prey upon. Therefore, walrus may be indirectly exposed to hydrocarbons through ingestion of their prey for an unknown period of time, which may lead to reduced fitness or chronic toxicity.

Effects of Abandonment and Reclamation. Effects of abandonment and reclamation activities are expected to be similar to those for construction.

Effectiveness of Stipulations and Required Operating Procedures

Baleen Whales

Under Alternative A, lease stipulations and required operating procedures (e.g., A-4, E-4, and K-6) would help prevent spilled fuel, oil, or other toxic materials from reaching the marine environment, minimizing potential effects to individual protected whales.

Required Operating Procedure F-1 requires, in most cases, aircraft to maintain an altitude of 1,500 feet (455 meters) above ground level. This would essentially eliminate disturbance to migrating or feeding whales in nearshore areas such as Cape Simpson and Lonely.

Stipulation K-3b is designed to "protect fish and wildlife habitat, preserve air and water quality, and minimize impacts to traditional subsistence activities and historic travel routes on Dease Inlet, Admiralty Bay, and Elson Lagoon." K-3b would considerably reduce impacts on protected whale species feeding and/or migrating in the nearshore waters between Cape Simpson and Point Barrow.

Stipulation K-6 (Coastal Area) includes as one of its objectives "to prevent contamination of marine waters" by preventing permanent facilities from being constructed within three-quarters of a mile from the coast. This could reduce potential impacts on coastal feeding whales, particularly bowheads, and their habitat in the western Beaufort Sea near Barrow and Peard Bay in the northeast Chukchi Sea. This would not, however, preclude a pipeline coming ashore connecting offshore leases with onshore infrastructure.

Ice Seals

Stipulation K-1 with its development setbacks from 24 named rivers would help protect marine habitats from large or very large spills that might originate at onshore wellpads. However, this stipulation may be less effective under Alternative A than it is under Alternatives B-1, B-2, C, and D because Alternative A names only about half of the rivers that are included in the latter alternatives. This same stipulation (under all alternatives) may allow wellpads to be placed in large river deltas, and pipelines to cross rivers, further leaving some risk of marine contamination from onshore spills.

Seasonal exploration restrictions in named NPR-A marine waters under Stipulation K-3b begin May 15, which is too late to protect ringed seal pups born as early as March. Other important waters are not named in K-3b (e.g., Peard Bay) and completely fall outside of seasonal protections. Required Operating Procedure C-1 would make up for some of the timing shortcomings by prohibiting seismic activities and the use of heavy equipment within 1 mile of known seal birthing lairs, and by requiring operators working through April 15 to consult with the National Marine Fisheries Service. The consultation requirement would presumably (but not assuredly) result in mandatory surveys for identification and avoidance of subnivean lairs, regardless of location. However, ringed seal pups will only be adequately protected if lairs are identified.

Other restrictions under K-3b would protect named marine waterbodies from development within three-quarter mile (seaward) of the coastline, but not farther out. While this would protect shoreline resources from most disturbances, it would not protect against contaminant spills directly into the marine environment. Stipulations may not adequately protect ringed and bearded seals against spills and discharges from marine traffic associated with development activities, but no very large spills are predicted to occur from this source.

Stipulation K-3b may help limit aircraft disturbance to seals using haulouts, as it states these activities shall be conducted to minimize impacts to concentrated wildlife resources. However, it lacks specificity such as recommended buffer distances. Stipulation F-1 strives to minimize effects of low-flying aircraft on specific wildlife, but also fails to list marine mammals.

Peard Bay and Kasegaluk Lagoon Special Area, both important to seals, are deferred from leasing until 2014. After deferral expiration, Stipulation K-8 would adequately protect seals from development and direct oil spill contamination in Kasegaluk Lagoon by prohibiting permanent oil and gas facilities from occurring there. No comparable stipulation would apply to Peard Bay. Stipulation K-6 prohibits most development within three-quarter mile inland from most of the NPR-A coastline, but not from Peard Bay southwest to Kasegaluk Lagoon.

Polar Bear

Many of the lease stipulations and required operating procedures in Alternative A would effectively protect polar bears and their habitats within the planning area. Required Operating Procedures A-1 through A-8 would ensure that solid, liquid, and hazardous wastes would not attract polar bears or degrade their habitat. They would also require a public safety plan that includes bear-interaction plans to avoid or minimize many potential human-bear conflicts. Required Operating Procedure C-1 would prohibit seismic activities and the use of heavy equipment within 1 mile of known polar bear dens and would require operators to comply with requirements under the Marine Mammal Protection Act. Required Operating Procedure E-5 would require that facilities be designed to minimize impacts of the development footprint, while Required Operating Procedure E-4 would require sound pipeline construction to minimize leaks and thus would help minimize take of listed species. Required Operating Procedure I-1 would require orientation programs for oil and gas personnel, informing them of the importance of not disturbing biological resources, including endangered species and marine mammals. Protective measure J indicates the BLM would not approve any activity that may affect a listed species, until it completes its obligations under applicable requirements of the Endangered Species Act. Lease Stipulations K-1, K-3, K-4, K-6, and K-8 through K-11 would confer some benefits to polar bears. These stipulations would: (1) limit activities along the banks of rivers and some lakes, reducing sources of disturbance in potential denning habitat; (2) limit activities in coastal habitats, reducing the potential for sources of disturbance and obstructions in this polar bear movement corridor; and (3) require year-round spill response capability during periods of broken ice or open water in certain inlets, bays, lagoons, and barrier islands important to polar bears.

Pacific Walrus

Required Operating Procedure I-1 would require lessees to implement a program to inform personnel about the importance of not disturbing biological resources, including marine mammals. This required operating procedure, in combination with other stipulations and required operating procedures, should minimize direct disturbance to walrus from human activities.

Lease Stipulation K-6 applies to non-deferred coastal areas and was developed to protect a variety of wildlife coastal habitat use. Under Alternative A, walrus utilizing non-deferred coastal areas would also benefit from K-6 restrictions. Alternative A would require all permanent oil and gas facilities (including gravel pads, roads, airstrips, and pipelines) established to support exploration and development activities be located at least three-quarters of a mile inland from the coastline to the extent practicable. Exploration and development activities would occur outside of the coastal areas used by walrus, though this restriction would not apply to the area currently deferred from leasing in northwestern NPR-A.

Lease Stipulation K-8b, which applies to the Kasegaluk Lagoon Special Area, prohibits permitting permanent oil and gas facilities within the boundary of Kasegaluk Lagoon Special Area. This would benefit walrus by eliminating the potential for loss of habitat and disturbance from oil and gas activities in this area, which is becoming increasingly important for seasonal aggregations of walrus.

Conclusion

Baleen Whales

The most likely effects Alternative A would have on bowhead, fin, and humpback whales are disturbance-related from marine shipping and barging; however, occasional vessel collisions are possible. If humpback and fin whales become more common in these northern seas as they have in recent years—likely related to a climate change effects of reduced sea-ice extent and prey range expansion—there may be a higher encounter rate with the NPR-A shipping traffic than might otherwise have been the case. Short-term avoidance behaviors including dives, direction changes, and temporary abandonment of areas may occur as the result of ship or aircraft traffic. Studies have not been conducted specifically on the long-term effects on bowhead whales from disturbance from aircraft and shipping traffic, but the number of activities associated with NPR-A activities that may cause disturbance are expected to be few, limited seasonally, and generally in areas/times where whales are not concentrated.

Under Alternative A, oil and gas activities and facilities could be located along many of the coastal areas of the NPR-A. Use and occupation of some coastal areas is limited because of Stipulation K-6 and to some extent K-4. Only in Kasegaluk Lagoon would oil and gas facilities be prohibited. There are special restrictions on facilities in Dease Inlet, Admiralty Bay, and Elson Lagoon, but activities could occur. Bowhead whales generally do not enter Harrison Bay, along the Beaufort Sea coast during the fall westward migration, but they have been documented on surveys (e.g., Treacy 2002). Historic and prehistoric harvest of bowhead whales took place at Pingok Island, further indicating the presence of whales near Harrison Bay (Libbey and Hall 1981). Noise-producing activities, including most (on-shore) seismic surveys and all drilling activities, would take place in winter (early December to mid-April) and onshore. It is possible that some seismic data collection could occur landward of the barrier islands at Atigaru Point and the Koguru River, but in these areas seismic is expected to be conducted in the winter over ice, not in open water. Therefore, it is unlikely that any impacts to bowhead, fin, or humpback whales would occur from exploration activities under Alternative A.

Spill analysis suggests that a terrestrial spill large enough to reach areas used regularly by bowheads and occasionally by fin and humpback whales is very unlikely. In-water spills (i.e., ship accidents and drilling on nearshore leases) cannot be discounted nor easily predicted and could have severe localized effects, but are generally expected to be unlikely. As previously noted, powerful summer and fall storms could drive barges ashore as happened in August 2000. Vessel strikes are the most likely impact to whales that may result in serious harm or death. They also appear to be rare but may occur at higher frequencies if shipping and barge traffic increases in the future.

The type and potential for effects to fin and humpback whales, should the recent observations actually herald a northward shift in range and/or increase in population size, are expected to be similar to those described for bowheads. If the sightings are of "strayed" animals, then it is unlikely that any population-level effects would occur.

Under Alternative A, the effects of non-oil and gas activities on marine mammals, particularly bowhead whales along the coast of the planning area, would likely be short-term and localized and occur within 1 mile of aircraft corridors, survey sites, recreational camps, and overland moves. The effects of oil and gas leasing and development activities would likely cause increases in noise and disturbance, primarily near Lonely, Cape Simpson, Point Barrow, Wainwright, and along shipping lanes. Effects would be somewhat localized (within approximately 2.5 miles of barging lanes) and limited to the summer open water period (Richardson and Malme 1993).

The effects of development under Alternative A on bowhead, fin, and humpback whales would likely be short-term. Overall, it is not expected that NPR-A oil and gas exploration and development activities under Alternative A would have a measurable population level effects on bowhead or other whale species; however, a low number of whale-vessel collisions may occur with lethal or sub-lethal effects.

Ice Seals

Under Alternative A, the most likely impact to ringed and bearded seals from non-oil and gas-related activities would be haulout disturbance by aircraft. Effects, however, will likely be negligible due to relatively low numbers of flights and the often benign response to overflights, particularly when seals are in the water. Impacts to ringed and bearded seals from oil and gas activities could include disturbance from the more frequent air traffic associated with oil and gas activities, disturbance to and/or crushing of pupping lairs, and the potential for a large or very large contaminant spill. The disturbances have the possibility of reducing fitness through elevated energetic demands, as well as diminished prey availability if fish resources are affected. Protection of ringed seal pups would be adequate if the National Marine Fisheries Service requires surveys for subnivean lairs when contacted by operators as directed under Required Operating Procedure C-1. Currently however, no guarantee exists that surveys would be required. Ringed and bearded seals within and adjacent to the NPR-A planning area could be negatively impacted under Alternative A more than under Alternatives B-1, B-2, and C, and less than under Alternative D.

Climate change effects—particularly loss of habitat due to diminishing sea-ice extent and concentration—could exacerbate effects of development on habitat use, quality, or availability for ice seals. How either species will adapt to changes in sea ice and snow conditions is currently debatable. Bearded and ringed seals are most likely to be impacted by sea ice loss through reduced availability of ice upon which to haul out for resting or pupping, reduced access to prey resources near haulout areas, and oceanographic changes associated with sea ice loss that favor more pelagic seal species (Cameron et al. 2010). Ice-dependent species that use near-shore areas, such as ringed and bearded seals, may be more susceptible to effects of oil and gas activities due to the added stresses associated with sea-ice habitat loss due to climate change. The mechanisms by which effects of climate change and anthropogenic activities interact are unknown, but could range from synergistic to countervailing.

Polar Bear

Under Alternative A, approximately 57 percent (13 million acres) of the NPR-A could be offered in future oil and gas lease sales. Approximately 2 million acres of the available lands would remain deferred from leasing until 2014 or 2018 (location-dependent), although a corridor for infrastructure associated with offshore development in the Chukchi Sea could be accommodated. Many of the currently protected coastal areas important to polar bears would be available for exploration and development when the deferrals expire. Therefore, although Alternative A is the “no-action” alternative in this IAP/EIS, it is expected that the potential effects of disturbance, habitat loss and alteration, and potential mortality due to development under Alternative A would be lower than under Alternative D, but greater than that under Alternatives B-1, B-2, and C.

Non-oil and gas activities would be highly localized (e.g., worksites or camps) and/or transient (e.g., surveys and inventories). While non-oil and gas activities may result in disturbance to individual polar bears and may prevent some polar bears from using small portions of habitat temporarily, the activities are not anticipated to have long-term impacts to individual polar bears or measurable impacts at the population level. Consultations with the U.S. Fish and Wildlife Service under the Endangered Species Act will address potential impacts associated with permitted non-oil and gas activities. Oil and gas activities may likewise result in disturbance to individual polar bears and may prevent some polar bears from using small portions of their habitat temporarily. Endangered species consultations will address those oil and gas activities that could affect polar bears and their critical habitat. Population-level impacts are therefore not expected as a result of oil and gas activities, with the exception of a large oil spill. Under some scenarios, a large oil spill could result in population-level effects or long-term impacts to the food chain. This risk is higher under Alternative A than under Alternatives B-1 or B-2; but it is the same or nearly the same as under Alternatives C and D, respectively.

Pacific Walrus

Under Alternative A, approximately 57 percent (13 million acres) of the NPR-A could be offered in future oil and gas lease sales. The 97,000-acre Kasegaluk Lagoon Special Area is deferred from leasing until January 22, 2014, after which it would become available for leasing and could accommodate a corridor for infrastructure. Stipulation K-6 would restrict permanent oil and gas facilities from a portion of the Chukchi coastline north of Peard Bay. Therefore, although Alternative A is the "no-action" alternative in this IAP/EIS, it is expected that potential effects of disturbance, habitat loss, and alteration, and potential mortality would be lower under Alternative A than under Alternative D, but greater than under B-1, B-2, or C.

Non-oil and gas activities would be highly localized (worksites or camps) and relatively transient (surveys and inventories). Non-oil and gas activities that result in short-term disturbance to individual or small groups of walrus, or temporarily prevent some walrus from using a portion of their terrestrial habitat, are not expected to have long-term effects to individual walrus or local populations. However, walrus frequently aggregate in large groups and are increasingly using barrier islands and other coastal habitats within the NPR-A during the late summer ice-free months, and those large groups (especially those with juveniles) are more susceptible to disturbance and stampede. Non-oil and gas activities that occur too close to aggregations of walrus at haulouts, even short-term activities, could lead to disturbance and mortality of many individuals, especially juveniles and those at the edge of the aggregation. Likewise, oil and gas activities that occur too close to walrus aggregations could have similar disturbance potential that could lead to local mortality events. Under some scenarios, a large marine oil spill could result in population-level effects to walrus from direct mortality and/or long-term effects to the local walrus prey base. This risk is higher under Alternative A than under Alternatives B-1 or B-2, but is the same or nearly the same under Alternatives C and D.

4.3.11.5 Potential New Mitigation Measures

Potential Mitigation Measure 1—Surveys for Sensitive Plant Species (new required operating procedure)

Objective: Minimize loss of populations of, and habitat for, plant species designated as Sensitive by the BLM in Alaska.

Requirement/Standard: If a development is proposed in an area that provides potential habitat for a BLM Sensitive Plant Species, the development proponent would conduct surveys at appropriate times of the summer season and in appropriate habitats for the Sensitive Plant Species that might occur there. The results of these surveys will be submitted to the BLM with the application for development.

Potential Benefits and Residual/Unavoidable Impacts: This potential new mitigation measure would reduce the probability that a development would destroy part or all of a population of a BLM Sensitive Plant Species. The probability of this happening is already low, due to the rarity of these species and the low percent of land that would be covered by development, but this added measure would reduce that probability even further. The expense of a survey is justified, despite the low probability of a conflict, because any loss of part or all of a population of a BLM Sensitive Plant Species could be a severe impact on that species. The cost would be minimal compared to total costs of a development, and would have to be borne only by those developments proposed in potential habitat. Despite this mitigation, residual, unavoidable impacts would be possible if a survey occurred, but failed to detect the presence of a population of a BLM Sensitive Plant Species.

Potential Mitigation Measure 2—Surveys for Sensitive Terrestrial Mammals (new required operating procedure)

Objective: Minimize loss of individuals of, and habitat for, mammalian species designated as Sensitive by the BLM in Alaska.

Requirement/Standard: If a development is proposed in an area that provides potential habitat for the Alaska tiny shrew, the development proponent would conduct surveys at appropriate times of the year and in appropriate habitats in an effort to detect the presence of the shrew. The results of these surveys will be submitted to BLM with the application for development.

Potential Benefits and Residual/Unavoidable Impacts: This potential new mitigation measure would reduce the probability that a development would destroy habitat or individuals of a population of the Alaska tiny shrew. The probability of this happening is already low, due to the rarity of this species and the low percent of land that would be covered by development, but this added measure would reduce that probability even further. The expense of a survey is justified, despite the low probability of a conflict, because any loss of individuals of a population of the Alaska tiny shrew could be a severe impact on that species. The cost would be minimal compared to total costs of a development, and would have to be borne only by those developments proposed in potential habitat. Despite this mitigation, residual, unavoidable impacts would be possible if a survey occurred but failed to detect the presence of a population of the Alaska tiny shrew.

Potential Mitigation Measure 3—Aircraft Avoidance of Walrus Haulouts (Addition to F-1 Required Operating Procedure)

Objective: same

Requirement/Standard: (add as new subparagraph) Fixed-wing aircraft used as a part of a BLM-authorized activity along the coast shall maintain a minimum altitude of 1,500 feet and a 0.5-mile buffer from walrus haulouts, unless doing so would endanger human life or violate safe flying practices. Helicopters used as part of a BLM-authorized activity along the coast shall maintain a minimum altitude of 3,000 feet and a1-mile buffer from walrus haulouts, unless doing so would endanger human life or violate safe flying practices.

Potential Benefits and Residual/Unavoidable Impacts: The potential exists for aircraft to cause serious adverse effects to individuals or groups of walrus on terrestrial haulouts due to disturbance that leads to trampling or loss of foraging and resting opportunities. However, this risk can be largely minimized with appropriate mitigation techniques, such as minimum altitude and distance requirements for aircraft in the vicinity of walrus on terrestrial or ice haulouts. Other marine mammals, including ice seals, utilizing terrestrial and ice haulouts would also benefit from this mitigation measure.

Potential Mitigation Measure 4—Marine Vessel Avoidance of Walrus Haulouts (K-6 Stipulation - Coastal Area)

Objective: (add as new sentence)

"Minimize disturbance of walrus aggregations on barrier islands or shorelines."

Requirement/Standard: (add as new subparagraph)

"Marine vessels should maintain a 0.5-mile buffer from shore when transiting past walrus using a terrestrial haulout."

Potential Benefits and Residual/Unavoidable Impacts: The potential exists for watercraft to cause serious adverse effects to individuals or groups of walrus on terrestrial haulouts due to disturbance that leads to trampling or loss of foraging and resting opportunities. However this risk can be largely minimized with appropriate mitigation techniques, such as minimum distance requirements for watercraft in the vicinity of walrus on terrestrial or ice haulouts. Other marine mammals, including ice seals, utilizing terrestrial and ice haulouts would also benefit from this mitigation measure.

Potential Mitigation Measure 5—Vessel Operation (Addition to H-1 Required Operating Procedure)

Objective: (same)

Requirement/Standard: (add)

c.6. Barge operators are required to demonstrate that barging activities will not have unmitigable adverse impacts on the availability of marine mammals for subsistence uses.

c.7. All vessels over 50 ft. in length must have an Automatic Identification System (AIS) transponder system on the vessel.

Potential Benefits and Residual/Unavoidable Impacts: Bowhead feeding areas along the western Beaufort Sea coast from Camp Lonely to Point Barrow provide an important contribution to the annual energetic needs of bowhead whales. Aggregation size varies by year but in some years thousands of bowheads feed within 20 nautical miles of this section of the NPR-A coastline. Reducing disturbance to feeding whales is important for them to meet their energetic requirements. In fall, whale hunters from Barrow hunt within the area from Cape Simpson to Point Barrow. Farther east, Nuiqsut and Kaktovik also hunt bowheads during the fall. Additionally, coastal areas of the NPR-A are important for other marine mammals (e.g., beluga concentration areas near Kasegaluk Lagoon or spotted seal haulouts at various locations). Mitigating possible impacts from barge traffic associated with the NPR-A is necessary to reduce interruption of subsistence hunts, which are protected by the Marine Mammal Protection Act. Placing automatic identification systems on vessels will help to analyze effects of traffic on vessels and provide information for total cumulative impacts from all anthropogenic activities.

4.3.12 Cultural Resources

For a discussion of cultural resources in the NPR-A see section 3.4.2 in Volume 1.

4.3.12.1 Activities Not Associated with Oil and Gas Exploration and Development

Aircraft and watercraft traffic, scientific investigations (e.g., archaeological, paleontological, and geological survey and excavation), summer camps, hazardous and solid waste material removal and remediation, overland moves and recreation associated with non-oil and gas activities could all have effects on cultural resources. Aircraft use would not directly affect cultural resources; however, it could have an indirect effect by making cultural resources more accessible to recreational and other users. Watercraft can also provide easy access to cultural resource locales.

The BLM and BLM permittees conduct archaeological, paleontological, and geological research, survey and excavation within the NPR-A. Surveys (pedestrian and aerial), excavation, and collection generally occur during the summer. Survey personnel often encounter cultural resources by chance because the cultural remains are generally located on or near the surface. While excavation and collection are destructive activities, they are necessary for the recovery of scientific data.

The temporary summer field camps commonly associated with scientific research or resource assessment generally affect small areas for one to three summer field seasons. Larger camps would most likely be located at the Inigok airstrip, Point Lonely Distant Early Warning-Line site, or the Ivotuk airstrip. Camps of this size would be established on existing gravel pads where available, and low-impact camping practices would be employed elsewhere. It is possible that larger camps could affect previously undocumented cultural resources, however, it is doubtful as previous research and surveys should have identified any cultural resources near these camps. Generally, temporary camps and the activities that are associated with them, such as aircraft use, on-the-ground survey and reconnaissance, hazardous and solid-material removal and site remediation, and recreation, would not have any discernible effect on cultural resources.

Prior to or during ground-disturbing activities, qualified cultural resources personnel would determine if cultural resources exist on the site and monitor hazardous and solid waste material removal and remediation. Determinations of National Register of Historic Place eligibility would be, and have been, conducted for sites undergoing hazardous and solid waste material removal and remediation to determine whether the sites being cleaned up are themselves archaeologically and historically important (e.g., Point Lonely Distant Early Warning-Line site, early exploration camps, pioneer exploration pads, and wells). Cultural resources monitoring would occur during the discovery, site-verification, risk-assessment, and site-evaluation stages, if ground-disturbing activities were to occur.

The BLM regulates non-oil and gas-related overland moves, which only occur during the winter months when there is adequate snow cover and depth of frozen ground. Nonetheless, it is possible that damage could occur to known or unidentified cultural resources. The prevalence of surface or near-surface cultural resources in the Reserve suggests that undocumented cultural resources could be damaged even using the best available practices.

However, since the number of overland moves is limited and usually takes place on previously examined routes, the potential impact to cultural resources is low.

Recreational use of the NPR-A primarily includes summer use by wilderness rafting enthusiasts and spring and fall use by big game hunters. Given the importance of waterways for transportation and subsistence to prehistoric and historic peoples, cultural resource sites are concentrated along these corridors and may be exposed by erosion over time. Therefore, recreational users camping on riverbanks and bars could encounter and affect these resources as a result of boating activities, and through unauthorized collecting of cultural material.

4.3.12.2 Oil and Gas Exploration and Development Activities

Effects of Seismic Surveys

Exploratory drilling for oil and gas is almost always preceded by seismic surveys which, on the North Slope, are almost always conducted during the winter, utilizing low-ground-pressure vehicles and when the frost and snow depth are sufficient to protect the tundra. Given those conditions, in most cases, any undiscovered surface or near-surface cultural materials that might be present on seismic lines, camp train routes, or camp locations should be reasonably well protected from adverse impact. The exception to this would be structural or skeletal remains exposed above the surface of the ground, however, in many cases, such remains are readily visible and avoided. Currently the vibroseis method is almost universally employed for terrestrial seismic data collection and rarely causes any significant disturbance to the ground surface or near-surface. The lines of a 3-D seismic program within a given area are closer together than those of a 2-D program, and therefore, there are more of them. As a result, the potential for impact is somewhat higher from a 3-D program.

Under Alternative A, seismic surveys could involve approximately 56,600 survey and camp train miles and approximately 538,000 survey and camp train acres. Given the conditions under which most North Slope seismic surveys are conducted and the methodology employed, there is only a slight chance that near-surface cultural material would be impacted and a low probability that undiscovered surface material would be encountered and impacted, except in the case of aboveground structural remains. It should be noted that as the area of potential impact becomes larger with the other alternatives, statistically, the possibility of impact to cultural resources increases. Nonetheless, overall, the probability of impact to cultural resources remains low.

Effects of Short-term Disturbance: Exploration and Delineation Drilling

The drilling of exploration and delineation wells would typically occur during the winter months. Under Alternative A, it is estimated that during the exploration or delineation phase as many as 326,684 acres could have ice and snow infrastructure constructed upon the surface of the landscape. However, because of the construction method, no significant ground disturbance is anticipated to occur and it would be unlikely that any near-surface cultural material would be impacted. Depending upon the location of a given drill pad, road, or airstrip, it is remotely possible that previously undiscovered surface cultural material could be encountered and impacted. Some surface or near-surface disturbance will occur at each well's cellar box location encompassing an area of approximately 64 square feet. This constitutes a potential total of slightly less than a third of an acre of surface or near-surface disturbance if the anticipated maximum number of wells is drilled. However, the potential for this aspect of the drilling procedure to encounter and impact any scientifically significant cultural resources is remote.

Effects of Long-term Disturbance: Development of Oil and Gas Infrastructure

Under Alternative A, surface or near-surface disturbance from construction activities could impact as much as 9,902 acres. Impact to cultural resources from this type of activity can occur in a variety of ways and levels of severity. Significant potential impact to cultural resources could result from the excavation of mineral material (gravel) needed for construction of the long-term oilfield production facilities. It is anticipated that a surface or near-surface area of 1,415 acres (2.2 square miles) would be impacted by the establishment of up to 40 material sources (borrow pits) producing as much as 40 million cubic yards of material. On the North Slope, areas of gravel accumulation are, by their geologic nature, usually well drained or at least better drained than the surrounding ground. Well-drained locales make the best camping spots and in a region dominated by wet tundra and standing water, they are at a premium. As a result, well-drained locations often have cultural sites associated with them. Past gravel mining activities on the North Slope have frequently encountered prehistoric and historic cultural material, and it would be expected that such would be the case under the Alternative A scenario. Additionally, when mineral material is laid down in the construction of pads, airstrips, and roads, it is possible that undiscovered surface or near-surface cultural material could be impacted, if present.

It is anticipated that in all but exceptional circumstances, oil pipelines will be elevated above the ground, constructed during the winter months from ice roads or pads, and will not have associated all-season roads or pads other than at processing or production facilities. Therefore, the potential impact to cultural resources resulting from oil pipeline construction would be limited to the laying down of ice roads or pads (previously addressed) and the placement of vertical support members. The process of drilling holes to set vertical support members will impact the surface or near-surface zone. Under Alternative A, a maximum of 818 miles of oil and feeder pipeline could be constructed. It is estimated that there would be 81 vertical support members per mile, for a total of 66,258 vertical support members. Drilling a single vertical support member borehole would impact approximately 4 square feet of the surface or near-surface zone. For 818 miles of pipeline, the total area impacted would be about 6 acres. Because the vertical support member borehole alignments comprise transects across the landscape, the chances of encountering and impacting cultural resource sites are raised considerably when compared to the probability of occurrence within a single 3.7-acre plot. If the natural gas pipelines were also placed on vertical support members, then the number of boreholes would be roughly doubled and the probability of encountering or impacting cultural material would increase accordingly. Nonetheless, because a cultural resource survey would be required prior to the initiation of work, the likelihood of encountering and impacting any cultural resource sites at a significant level, generally, remains low.

While it is possible that gas pipelines might be elevated on vertical support members, it is more likely that they would be buried. Under Alternative A, this would assume that up to 800 miles of trench approximately 5 feet deep and 4 feet wide would be excavated, impacting 484 acres of surface or near-surface area. There would also be an area of associated surface or near-surface disturbance 5.5 feet wide bordering each side of the trench, totaling 1,066 acres. Trench excavation increases the probability that cultural sites might be encountered and impacted because, similar to vertical support member alignments, trenches are transects across the landscape.

One of the most important factors in regard to the probability of adversely affecting cultural sites is the geographic location in which a given development activity will take place. Since cultural resource sites result from human activity, to some degree, locales of probable occurrence can be identified. This has been demonstrated by previous reconnaissance, survey, and excavation or collection. The areas of highest probability for economically recoverable oil and gas in the NPR-A include some areas known to have a slightly above-average density of cultural sites and a moderately high potential for the presence of undiscovered sites.

Effects of Oil Spills and Gas Releases

If a catastrophic terrestrial oil or gas well blowout occurred in an area where surface or near-surface cultural resources were present, the resources would probably be destroyed or rendered scientifically valueless either by the blowout or the subsequent cleanup and remediation procedures that followed. Large-volume spills are also very low-probability events, and if one occurred, the impact to surface or near-surface cultural material could be similar to those associated with a blowout. A large-scale gas release would probably have little effect upon cultural resources, depending upon the degree of invasiveness of whatever cleanup and remediation actions were necessary. Otherwise, an estimated 65–80 percent of all oil spills are confined to a pad, with the remainder generally confined to an area adjacent to the pad.

During exploration, it is assumed that most spills would occur on an ice pad, ice road, or frozen landscape, resulting in cleanup that is less invasive than the cleanup required by a spill on the landscape during summer. However, if the oil temperature is high enough, it could melt through the snow and come in contact with the ground, and impact surface or near-surface cultural resources, if they are present. The effects of spills and spill clean-up associated with development would be similar to those associated with exploration activities except that they could occur during the snow-free months. Although cleanup from the spills could be more invasive because the ground surface would not be frozen, the chance that cultural resources would be impacted remains problematic. However, if present, surface or near-surface cultural material could be impacted. Because the vast majority of cultural resource sites lie in the surface or near-surface zone, any cleanup or remediation procedure would probably significantly impact or destroy the site unless archaeological excavation of the site was part of the remediation program. Contamination by oil would make radiocarbon dating of that site impossible. The spilled oil would seep into charcoal, bone, wood, or other materials at the site that would be used for radiocarbon dating, and contaminate them so that their true dates could no longer be accurately determined. Nonetheless, since the occurrence of scientifically significant cultural sites is sporadic, the probability of encountering and impacting noteworthy material is relatively low. A gas release would probably have little effect on cultural resources.

Effects of Abandonment and Reclamation

Abandonment and reclamation of infrastructure would, under most circumstances, have limited, if any, impact on cultural resources. This assumption arises from the fact that any impacts to cultural resources at the site being reclaimed probably occurred during the development and/or operation of the site. If previously unimpacted areas are encompassed by the abandonment and reclamation activities, which would seem counterproductive to the desired end result, then it is possible that impacts to undiscovered surface or near-surface cultural material could occur. Nonetheless, the probability of encountering scientifically significant material remains low, as work involving previously undisturbed areas would require a cultural resources survey.

4.3.12.3 Effectiveness of Stipulations

Umbrella coverage and protection for cultural resources on federal lands is provided by the National Historic Preservation Act, particularly Section 106 of that act, as well as the Archaeological Resources Protection Act, and the Antiquities Act. Under Alternative A, the primary safeguard for cultural resources is Required Operating Procedure E-13, which states that lessees will conduct a cultural resources survey before engaging in any potential ground-disturbing activity. Most aspects of oil and gas exploration and development activities fall into this category, including all types of drilling, construction of ice roads, pads, and airstrips, and all development phase construction. The required cultural surveys are primarily pedestrian surface reconnaissance of the areas where the permitted activities are to take place, and are generally centered on examination of unvegetated locales (if any are present) where organic and mineral soil is exposed. In areas where cultural material is known or believed to be present greater scrutiny is used, particularly at locations where excavation will occur such as borehole drilling, trenching, and mineral material extraction.

Additional protection is provided by Required Operating Procedure C-2, which affords protection to streambanks, and minimizes soil compaction and impacts to the surface and near-surface of the landscape. Also contributing to the protection of cultural resources is Required Operating Procedure I-1, which requires that all personnel involved in oil and gas-related activities, be made aware of cultural and archaeological concerns that relate to the region or work site. Additional protections that apply in select biologically sensitive areas also provide protections for cultural resources in that the floodplains, terraces, and banks of specific rivers where the presence of cultural material has been recognized is safeguarded by construction setbacks. Contributing to these protections are the inventorying and monitoring that has been conducted sporadically in the NPR-A by the U.S. Geological Survey, the BLM, other agencies and permittees over more than six decades. If cultural materials are known to be present in an area where they will be impacted by planned oil and gas exploration or development activities, a mitigation procedure concomitant with the scientific significance or value of the material will be determined by the BLM. If previously undiscovered cultural material is encountered during oil and gas exploration or development activities, the activity will cease, and the BLM will be notified. The BLM in consultation with the SHPO will then evaluate the situation and determine an appropriate mitigative procedure before the activity can recommence.

4.3.12.4 Conclusion

The primary potential impact to cultural resources under Alternative A would result from the excavation of gravel for construction of permanent facilities, gas line trenching, and vertical support member borehole drilling. A lower potential for impact exists from exploration activities, and a lower potential still from non-oil and gas activities. Less than 3 percent of the NPR-A has been surveyed for cultural resources. Nonetheless, activities that occur near surveyed areas may have a greater likelihood of impacting cultural resources because discovery (non-Section 106) surveys and inventories are most often conducted in areas where cultural sites are expected to be found (although site density can vary greatly from one area to another). Since cultural resources surveys are required before any potential ground-disturbing activity can take place, the potential impacts to cultural resources from oil and gas exploration and development activities are low. Indeed, the potential effects of climate change on cultural resources (described in section 3.4.2.2 in Volume 1) could be greater than the potential impacts associated with Alternative A.

4.3.13 Subsistence

4.3.13.1 Activities Not Associated with Oil and Gas Exploration and Development

Activities not associated with oil and gas exploration and development include: aircraft and watercraft use; research activities, including remote camps associated with research; winter overland moves; waste removal; and recreation. All of these activities have the potential to affect subsistence use. Under Alternative A, non-oil and gas activities requiring BLM permits could be subject to the protective measures outlined in Chapter 2 (Table 2–3). See section 4.2.1.1 for a detailed description of the types of non-oil and gas activities that may occur in the planning area.

Aircraft Use

Under Alternative A, it is anticipated that there will be a certain level of aircraft activity associated with the management of the NPR-A, including aircraft activity in support of research, surveying crews, or other projects. This aircraft activity includes fixed-wing surveys, such as those conducted to determine wildlife populations; point-to-point flights by both fixed-wing aircraft and helicopters; and helicopter-supported surveys. Aircraft operating under a BLM permit for non-oil and gas projects would be required to follow the stipulated altitude and activity rules; however, the BLM would have no authority over private aircraft not associated with permitted activities. It is anticipated that most non-oil and gas aircraft activity would occur during the summer months in support of research or other projects; however, aircraft use could also occur during the winter in support of remediation or clean-up work, as well as some climate research activities.

Of all non-oil and gas activities, aircraft use, especially the use of helicopters, has the most potential to disrupt subsistence use in the planning area. As noted in the terrestrial mammals section (see section 4.3.9.1), caribou show a definite response to low-flying aircraft, resulting in displacement away from the aircraft activity. Under certain conditions (e.g., insect harassment, hard or deep snow cover), aircraft activity could increase stress in these animals, possibly leading to failed breeding or even death of animals. Fixed-wing flights that would occur in the planning area would be conducted at a sufficient altitude to minimize impacts to wildlife. There are three major exemptions from this stipulation:

wildlife survey flights; takeoffs and landings; and flights in weather that render it unsafe to fly at the recommended altitude.

Helicopters are commonly used in support of most field activities in the NPR-A as a result of the limited amount of adequate landing areas for fixed-wing aircraft and the lack of road or trail systems. Statements from local hunters, including direct complaints to the BLM and the North Slope Borough Department of Wildlife Management, indicate that helicopters frequently disrupt hunting parties by scattering and displacing caribou or other game. This can also result in a missed harvest because hunters are reluctant to take a “spooked” animal because the meat has a bad flavor (USDOI BLM Subsistence Advisory Panel 2002, 2004, 2005, 2006a, 2006b). This type of disrupted harvest directly impacts the hunter in terms of lost time, effort, and resources (primarily fuel). Subsistence harvesters also describe the stress that occurs when they are out hunting, hear a helicopter operating nearby, and worry that the helicopter will approach and disrupt the hunt.

Watercraft Use

Like aircraft, watercraft (e.g., airboats, outboards, jet boats, sailboats and non-powered boats) would be allowed in the planning area. Watercraft operations would be managed similarly to aircraft operations and all BLM-permitted watercraft users would be required to follow the appropriate regulations. Non-oil and gas watercraft activities would have a localized effect that could cause subsistence species, such as caribou, to avoid the immediate area of activity (i.e., along the riverbank or near the lake shore) or cause the short-term abandonment of habitats by wildfowl. Watercraft use is not anticipated to disrupt harvesters as much as aircraft use because of watercrafts’ limited area of effect and the relative low level of use. The effect on harvest patterns would be dependent on the frequency of the watercraft activity, but would most likely be a temporary and local effect on harvest patterns.

Research Activities

Scientific research and data collection in a variety of disciplines (e.g., biological, geological, archaeological, and paleontological) are frequent occurrences in the NPR-A. Research and data collection activities could require the establishment of temporary or semi-permanent camps; the use of aircraft, watercraft, or off-highway vehicles; and the disturbance of subsistence activities, wildlife, vegetation, or soil. Temporary camps could cause displacement of subsistence resources from the immediate area for the duration of the camp, and could also cause harvesters to avoid the area of the camp while out hunting so as not to discharge a weapon in the vicinity of people. The larger the camp and the longer the occupation, the greater the potential effect to subsistence users. Wildlife attracted to camps, such as bears or foxes, could be killed as a result of defense of life and property, but not at a level that would affect the overall population or availability of these resources for subsistence harvesters.

Personnel walking on the tundra could disturb caribou and muskoxen to a greater degree that other activities (Murphy and Lawhead 2000). Depending on the timing, location, and intensity of research and data collection, these activities could cause terrestrial mammals, birds, and fish to move out of areas where subsistence harvesters would anticipate them to be available, thus affecting subsistence patterns for the duration of the activities. Residents of Nuiqsut have noted a decrease in bird populations that they attribute to foxes (Stephen R. Braund and Associates 2003a, b). Scientists observing nesting waterfowl could influence predator behavior by attracting predators to the nest. The effects of research activities on subsistence harvest patterns would be temporary and localized (e.g., limited to the camp and data collection areas). Aircraft and watercraft use associated with research would have the same effects as those described above. Additionally, camps and or research projects that are supported by helicopter usually have a fuel cache located nearby. These caches require a permit from the BLM, which specifies requirements for containment and proper handling, and the caches are not expected to result in an impact to subsistence resources or land use. Researchers' use of ATVs or snowmachines has the potential to temporarily displace resources from the area of use, but this activity is not expected to appreciably affect subsistence harvesters because a very small amount of research is carried out using these types of vehicles.

In recent years there has been an increase in the number and intensity of research projects in the NPR-A. Reasons for this increase include industry-driven ecological baseline monitoring projects and growing attention to climate and ecosystem change. Consistent with older understandings of the effects of non-oil and gas activities, it is the increase in aircraft use associated with research projects that could create the greatest disturbance to subsistence activities. The amount of scientific research and data collection associated with lease sales would likely be greater under Alternative A than under Alternative B-1 or B-2 but would likely be less than under Alternatives C and D.

NPR-A residents have also expressed concerns that animals do not behave normally when they are disturbed by aircraft and researchers using aircraft are therefore not collecting accurate biological data (Tracey 2010). This concern, compounded by common sentiments that local requests for fewer aircraft are ignored, risks creating cynicism among NPR-A residents about the findings of scientific research on subsistence resources and could negatively impact co-management regimes, the sharing of traditional ecological knowledge, and other subsistence-related collaboration between researchers and Iñupiat.

Recreation and Film Permits

Recreational uses of the planning area include hiking, rafting, canoeing, wildlife viewing and bird-watching tours that are primarily conducted by commercial guiding companies. There have been five to nine such special recreation permits issued per year from 2009-2011. Under Alternative A (no-action alternative), commercial permit holders would continue to be subject to the regulations outlined in the records of decision of the 2004 Northwest NPR-A IAP/EIS and the 2008 Northeast Supplemental NPR-A IAP/EIS. Non-guided rafting and bird watching tours could take place during the summer, but the frequency, duration, and intensity of this use are difficult to predict. Non-guided recreational users are not legally bound to any of the protective measures of Alternative A, but must comply with existing laws and regulations for the area. Recreational use could disturb the movements and habitat use of subsistence species, causing a short-term, localized effect. Recreational users would likely frequent waterways shared with other users, such as subsistence hunters, potentially resulting in resource user conflicts. Non-resident hunters of Game Management Unit 26A, which encompasses the entire planning area, could, according to State hunting regulations, harvest bear, caribou, or moose. However, recreational sport hunting is limited by difficulties accessing the area, by restrictions on the timing of hunts, and by State bag limits. Hunting guides can operate in the NPR-A under BLM permit and there have been up to five such permits issued per season in recent years (2009-2010). However, the guides typically use areas that are very distant from communities. Therefore, any effects on subsistence harvest patterns caused by recreational users and guided hunters would be localized and temporary.

Solid and Hazardous Waste Removal and Remediation

Solid and hazardous waste removal and remediation, including the monitoring of existing clean-up sites and aging infrastructure (e.g., wellheads) would occur under Alternative A. These activities would involve conducting site characterizations, removal of hazardous materials, possible stockpiling of contaminated materials, and eventual disposal in an appropriate facility. Site characterizations would be completed during the summer and access would most likely be by helicopter. This use could cause temporary and localized displacement as described above under aircraft use. Equipment to be used during the clean-up process would be moved to the area over ice roads or over snow packed trails during the winter or, depending on the location of the clean-up activity, could be barged to the area during the summer. Ice road construction, or winter movement over a snow-packed trail, could displace resources from the route during the activity. However, hunters could take advantage of snow trails and ice roads to travel to hunting grounds. The barging of clean-up equipment or the resulting contaminated material could affect sea mammal and bowhead whale hunting. Site cleanup and remediation activities could temporarily divert or disturb caribou, muskoxen, and grizzly and polar bears, but would have little effect on long-term subsistence harvest patterns. Short-term effects (a "plume" created by clean-up activities) could include an increased potential for contamination of subsistence species, particularly fish, in the area around the cleanup site. Long-term effects of the cleanup of waste sites could include a decreased potential for contamination of subsistence species. Communities on the North Slope have placed a high value and fully support this type of activity (USDOI BLM Subsistence Advisory Panel 2005, 2006a, b; Fritz 2010). Effects on subsistence harvest patterns by this activity would be localized and temporary, although many contaminated sites are located near NPR-A communities and can therefore affect nearby resources such as fishing areas.

Overland Moves

Overland moves, such as supply trips to communities via Rolligon, would occur only by permit and would be subject to the requirements of this alternative (Required Operating Procedures C-1 to C-4). These moves would only occur in the winter on frozen tundra with an adequate accumulation of snow pack, or on ice roads. Overland moves can disturb or deflect caribou, polar bears, grizzly bears, muskoxen, wolves, and wolverines from the immediate area of the travel route. The effects of overland moves on subsistence harvest patterns would also be localized and of short duration; however, their effects on harvest patterns would increase as the frequency increased. In cases where oil and gas ice roads were used for non-oil and gas activities, increased traffic could result in additional effects on harvest patterns. These effects would last for as long as the ice road was used, and would vary depending on the intensity and frequency of traffic.

4.3.13.2 Oil and Gas Exploration and Development Activities

Alternative A, the no-action alternative, constitutes a continuation of the BLM's existing management practices that were established in the records of decision for the Northwest NPR-A IAP (January 2004) and the Northeast Supplemental NPR-A IAP (July 2008). Under Alternative A, approximately 57 percent (13 million acres) of the planning area would be available for oil and gas leasing. Approximately 2 million acres of those available would remain deferred from leasing: 1.57 million acres in the far northwest corner of the NPR-A are deferred until 2014 and approximately 425,000 acres north and east of Teshekpuk Lake are deferred until 2018. Teshekpuk Lake and its islands would remain unavailable for leasing and no oil and gas leasing would occur in the more than 9 million acres that constitute the southern NPR-A. Alternative A accommodates a corridor for infrastructure associated with offshore development in the Chukchi Sea.

Effects of Disturbances

Seismic Survey Activity

Seismic surveys are permitted by the BLM and are conducted to gain an understanding of the subsurface geology of a region in order to identify locations for exploratory drilling. Refer to section 4.2.1.2, "Exploration," items 1-4 on pages 12 through 17 for a thorough description of seismic surveys in the NPR-A. Any given seismic survey covers a large area and consists of 8-10 vehicles that travel over the tundra when conditions allow, stopping to produce a sound source that is recorded by line of geophones strung out across the ground and connected to 8-10 receiver vehicles. Support for the survey is provided by a mobile camp unit consisting of sleigh-mounted trailers pulled by tracked D-7 bulldozers and assorted tracked and wheeled vehicles. The mobile camp includes a kitchen, diner, washroom, sleeping rooms, offices, generator rooms, and storage areas and is moved every few days during the operation. Seismic surveys can only be conducted when frost and snow cover are at sufficient depths to protect the tundra and shall cease when the spring snowmelt begins.

On average, two seismic surveys per year were conducted from 1990 to 2011, but the frequency is projected to decline for the next 10-20 years. Areas with the highest potential (the northeast corner of the NPR-A) have been nearly completely imaged with 3-D seismic and new seismic operations in the NPR-A have ceased. New exploration surveys in the northeast are unlikely; however, development in the Greater Moose's Tooth and Bear Tooth Units could lead to updated seismic acquisition. If a new play or fairway is established in the medium oil potential area, future exploration focused seismic acquisition is possible. Exploration 3-D seismic in the areas south and west of the oil and condensate potential areas is only likely if gas production is economic or new discoveries are made associated with the Umiat Field development.

In Alternative A, it is foreseeable that there would be up to 5 exploration-focused seismic surveys and 6 production-focused surveys. Alternatives B-1, B-2, C, and D estimate increasing numbers of acres of seismic surveys (Table 4-11). In all alternatives, both 2-D and 3-D exploration focused and 3-D development focused seismic work is expected to occur.

Because seismic exploration by vibroseis occurs during the winter months, the primary subsistence activities that may be impacted include fishing, trapping, and caribou and furbearer hunting. Seismic activity has the potential to affect the following terrestrial subsistence resources: wolves, caribou, wolverine, and polar bear. Statements by community members from Barrow and Nuiqsut have indicated that seismic exploration does interfere with overland travel by snowmobiles (USDOI BLM Subsistence Advisory Panel 2002). Specifically, the deep ruts left in the snow by seismic vehicles freeze, creating difficult terrain to traverse, resulting in excessive wear-and-tear on both snowmobiles and the sleds that are pulled behind them. Additionally, there is the potential for a machine to become inoperable, which would require Search and Rescue services. Replacement or repair of these tools that are used for subsistence harvesting is costly.

Additionally, subsistence hunters report that seismic activity displaces game, especially caribou, wolves, and wolverine from the area being surveyed (USDOI BLM Subsistence Advisory Panel 2006b). Because of the harsh conditions during the winter, many caribou hunters base at remote hunting cabins, many of which are located on BLM lands. If seismic activity occurs near a hunter's cabin, the resulting displacement causes the hunter to have to travel farther away. Disturbance of subsistence activities by seismic activities affects subsistence users in the following ways: loss of subsistence food; loss of time; loss of money; increased stress and anxiety; increased risk of equipment failure; and increased risk of loss of life or serious bodily injury. These affects may also put more responsibility on local municipalities to provide rescue response. Similarly, hunters who conduct day trips from their community have the potential to experience similar impacts.

Although it is highly unlikely because the lake would continue to be unavailable for leasing, the use of airguns for boat-based seismic work could occur in Teshekpuk Lake during the summer under Alternative A. Airguns have been shown to affect mortality in eggs and juvenile fish, and result in flight response for adult fish (see section 4.3.7.1). These activities could affect the subsistence harvest of broad whitefish, arctic grayling, burbot, and lake trout in river and stream systems connected to Teshekpuk Lake, including the Miguakiak and the Ikpikpuk rivers. There is potential for long-term impacts to subsistence fishing if large quantities of eggs and/or juvenile fish suffer mortality. Altogether, these effects could result in lower harvests for subsistence users. In addition, subsistence fishers who customarily utilize Teshekpuk Lake would likely avoid setting nets or fishing in the lake during the timeframe of this activity. Summer seismic activity in Teshekpuk Lake would primarily affect the communities of Barrow and Nuiqsut.

Exploratory Drilling

Exploratory drilling, which is carried out in order to test potential locations that have been identified by seismic exploration as likely to contain subsurface fluids or gas, can have several impacts on subsistence activities and resources. See 4.2.1.2, "Exploration" on page 12 for a complete description of oil and gas exploration.

Since the resumption of leasing in the NPR-A in 1999, exploration has resulted in an average of three wells per year and all exploration has occurred from seasonal ice pads. There have been 29 exploratory wells on 28 federal leases in the Reserve, including 15 in the Greater Moose's Tooth Unit and one in the Bear Tooth Unit. The scenario for development under Alternative A it is estimated that there will be a need for a total of

208 exploratory and delineation wells for oil and gas. Wells that show potential may be "suspended" and left with what is known as a "Christmas tree" at the surface.

Summer activities associated with exploratory drilling would result in impacts to subsistence resources and users similar to those discussed above under non-oil and gas activities—namely, displacement of resources due to aircraft or watercraft use; impacts to hunters from disrupted hunts; and possible increase in the amount of time, effort, and fuel needed to harvest displaced animals. Commonly at least three summer helicopter resource surveys are required for each exploratory well prior to drilling and additional trips are needed to identify access routes and stream crossings. Impacts to harvesters during the summer would be greatest during those times that caribou are intensively harvested, namely the late summer/early fall months of August through October, when caribou are considered in their prime before the fall rut.

Direct impacts to subsistence users and resources from an exploratory drilling operation would be similar to those discussed above under seismic exploration, including: displacement of resources away from the drill site; possible impacts to overwintering fish from water withdrawals, river crossings, and fuel spills near ice airstrips; and increased time, effort, and expense during hunting. Ice roads and/or packed snow trails are customarily used by local residents during the winter, both by snowmobile and truck/car. The presence of these types of access may concentrate hunting efforts along the route(s). In addition, increased traffic by locals increases the likelihood that resources such as caribou will be displaced from the route. Hunters from Anaktuvuk Pass are more likely to use the Umiat area during winter hunts and could be disrupted by oil and gas activity in that area.

Caribou could be present at any time of the year in the NPR-A. The Teshekpuk Lake Caribou Herd, which uses the area with the highest potential for industry, is not habituated to oil and gas activities. Muskoxen are rare in the NPR-A, but, like moose, would likely avoid activity areas and use riparian areas. Other terrestrial mammals (e.g., grizzly and polar bears, wolves, and wolverines) would also avoid oil and gas activity areas, although some animals (e.g., denning grizzly and polar bears) would not be able to avoid activity areas. In addition, if grizzly and polar bears were to associate oil and gas activity areas with food, the bears might become attracted to them. Oil and gas activity areas would be likely to attract foxes, which associate such areas with denning habitat and food in the form of handouts and trash (Burgess 2000).

Overwintering fish could be affected by exploratory drilling activities, but stipulations lessen the potential for impact to this resource by limiting the placement of temporary infrastructure and fuel caches. Depending on the location of the ice pad, harvestable vegetation such as berries or willow leaves could be impacted during the summer immediately following the activity. However, this would be temporary and only cover a small amount of the harvesting area for any subsistence plants.

Exploratory drilling scenarios under Alternative A would not be expected to affect marine mammals unless the barging of equipment to staging areas was required during the open water season. If barging were to take place during the fall bowhead whale hunt, this activity could affect whalers from Wainwright, Barrow, and Nuiqsut. Other, smaller-scale sea mammal harvests could also be affected. Seals may also use larger rivers in the NPR-A (e.g., the Ikpikpuk, the Nigliq Channel of the Colville Rivers, the Kuk River) in the summer and the nearshore environment in late winter and early spring. Aircraft traffic, vehicle traffic on nearshore ice roads, and activities near the rivers could affect spotted, ringed, and bearded seals by increasing their levels of stress and restricting their access to some habitats.

Development and Permanent Facilities

This IAP's projection of potential oil and gas development is less robust than that presented in earlier plans. Current oil discoveries and the identified prospects within about 30 miles of the Alpine Central Processing Facility (CD-1) will most likely be developed as satellites to that facility, and their footprints would be similar to that for existing Alpine satellites. The estimate for discovered and undiscovered oil economic resource under Alternative A is 723 million barrels of oil and 11.065 trillion cubic feet of gas. Under Alternative A, the estimated short-term surface disturbance for all potential discovered and undiscovered oil and gas related activities (detailed in Table 4-14) is 366,884 acres.

Once oil is found in commercial quantities, companies enter into the Development Phase of operation. This includes the construction of permanent facilities, including: roads, pipelines, gravel drilling/production pads, airstrips, central processing facilities, and possibly staging areas to store equipment and supplies during the construction period. The large amount of gravel needed during the construction phase would require companies to locate and utilize gravel pits, or barge gravel to the area. Under Alternative A, it is estimated that there will be a need for 12 central processing facilities for oil (one 10-acre, others 40 acres each) and 30 central processing facilities for gas (10 acres each). In conjunction with these facilities, there are other support structures, such as gravel production pads, gravel runways, in-field gravel roads, several types of pipelines, and other associated structures that will also cause surface disturbance.

Among the alternatives, Alternatives A and B-2 would cause the same amount of disturbance: more than Alternative B-1 but less than Alternatives C or D. After construction is completed, the production phase would begin. Because the development would be roadless (i.e., not connected to outside oil and gas infrastructure by gravel road, although gravel roads would be constructed between the productions and the central processing facility), primary access to the area would be by aircraft. Although a reliable projection of the number of flights is not possible, development of five satellite productions pads for Alpine was estimated to result in 2,500 "non-operational" helicopter flights per summer in addition to the equal number associated with the existing central processing facility and satellite. An average of 45 to 70 one-way flights per month was estimated to occur in the winter during an approximately six-year construction phase, with as many as 245 such flights during certain months, and 0 to 340 such flights in the summer with as many as 615 per month. Approximately 70 to 90 operational flights per month could occur per month during winter and summer, and once operations began flights could average 8 to as many as 32 flights in winter per month and 8 to as many as 80 flights per month in summer.

If oil development occurred in the northeastern NPR-A, regional pipelines would most likely be constructed from the planning area to the Alpine oil field and would then connect to the Kuparuk River Unit and the Trans-Alaska Pipeline System. The actual locations of new pipelines in the NPR-A would depend on the location and sequence of commercial-sized discoveries and it is not possible to predict where or when such fields would be discovered and developed. However, the connection via aboveground pipelines of production pads to central processing facilities, and from central processing facilities to the existing oil pipeline system could result in travel and access issues for harvesters utilizing the planning area. For example, the speculative future oil pipeline corridors as depicted in Figure 4—9 in section 4.2.1.2 surround the community of Nuiqsut, creating obstacles between the community and its primary harvest area to the west and the Colville Delta to the north. Under all alternatives, pipeline height is stipulated as a minimum of seven feet from ground surface. Harvesters in Nuiqsut have expressed concern that pipeline heights designed to allow the passage of caribou are not sufficient for the passage of moose, which are commonly harvested along the Colville River between Nuiqsut and Umiat (USDOI BLM 2010).

If commercial gas is developed in the NPR-A, the most likely design would include buried regional gas pipelines that would converge at a hypothetical hub such as Inigok before being transported via a 100-mile trunk line to a future gas conditioning plant near Pump Station 1 of the Trans-Alaska Pipeline System. This design would result in a 15-foot-wide area of surface disturbance along the length of the pipeline route and compression stations on five to ten-acre pads every 120 miles. Although winter burial of gas pipelines would potentially disrupt caribou and subsistence species, because they would be underground and would not converge close to a community, gas pipelines would not present the hardships for subsistence hunters that aboveground oil pipelines would.

Alternative A could result in numerous impacts to both important subsistence species and to subsistence hunters' access to traditionally used areas. As discussed in section 3.4.3, "Subsistence" in Volume 1, Nuiqsut, Barrow, Atqasuk, Wainwright, and Anaktuvuk Pass depend on the Teshekpuk Lake Caribou Herd and over 40 Alaskan communities depend on the Western Arctic Herd of Caribou. Caribou could be present at any time of the year in the NPR-A, and neither the Teshekpuk Lake Herd nor the Western Arctic Herd are habituated to oil and gas activities. Prior to becoming habituated to development activities, caribou would likely be wary of and avoid the new infrastructure and associated activities (USDOI BLM 2003). During the construction phase, caribou would most likely avoid the area of development, due to the noise and disturbance caused by construction activities. The effects of disturbance from permanent oil and gas facilities on terrestrial mammals during the production phase would be of relatively long duration, but would be local in nature. This disturbance would consist of noise from the central processing facility, noise, and visual impacts from traffic on the roads between the production pads and the central processing facility, and aircraft flights to the area. These effects would continue until species were able to habituate to the new environment, which could take several years (e.g., for infrastructure), or could never occur (e.g., for human and vehicle activities (Murphy and Lawhead 2000)).

Under Alternative A, the current status of the area north of Teshekpuk Lake, which provides core calving and insect-relief habitat for the Teshekpuk Lake Caribou Herd, would remain unchanged: approximately 425,000 acres north and east of Teshekpuk

Lake would remain deferred from leasing until 2018. Teshekpuk Lake and its islands (approximately 219,000 acres) would remain unavailable for oil and gas leasing. Alternative A would provide better protection for the Teshekpuk Lake Herd than Alternative D would, but not as much protection as Alternatives B-1, B-2, and C. For the Western Arctic Caribou Herd, Alternative A would result in fewer impacts than Alternatives B-1, B-2, C, and D because the unplanned portion of the NPR-A, including all of the prime calving and insect relief areas of the Western Arctic Caribou Herd, would be unavailable for leasing.

Because waterfowl are not present in the NPR-A in the winter, they are not affected during that time by oil and gas activities that may occur. However, both winter and summer oil and gas activities could result in changes to nesting and molting habitat that affect waterfowl's use of the Reserve. Development and permanent facilities could make previously used nesting and molting habitat permanently unavailable. Gravel extraction could create new habitat—dredge ponds–favorable for the survival of waterfowl, as these deep ponds would be inaccessible to predators. However, waterfowl could be negatively affected by vehicle strikes (e.g., aircraft and trucks), and accidental collisions with structures and power lines (USDOI BLM 2003). Increases in fox and other predator populations associated with human activities could also result in an increased risk for predation of molting geese.

In the past, Iñupiat subsistence users associated fish kills with oil and fuel spills and with seismic testing across waterbodies (Edwardson 1976). However, these effects have not been cited as occurrences since the early 1980s and likely have been corrected with improved seismic testing techniques and hazardous materials handling and transport methods. Fish and fish habitats could be affected by water withdrawals, gravel mines, changes to hydrologic regimes due to infrastructure (e.g., pads, roads, causeways, docks, bridges and culverts), increases in turbidity and salinity, oil and hazardous materials spills, and access to new habitats. These activities have the potential to reduce fish populations, divert fish from their normal locations, kill large numbers of fish, or contaminate fish populations and habitat. Depending on the event or activity, effects could be widespread, last from one season to several years, and result in population level effects on fish.

Alternative A could result in subsistence hunters avoiding previously used areas. Statements by residents of Nuiqsut (USDOI BLM 2010) and data presented by Pedersen et al. (2000) and Pedersen and Taalak (2001) confirm that Nuiqsut harvesters avoid development. The data shows that approximately 78 percent of the 1993 and 1994 caribou harvests occurred farther than 16 miles from the development east of the Colville River. In addition, 51 percent of the 1999-2000 harvests occurred at distances farther than 16 miles from the Alpine field and 27 percent occurred 6 to 15 miles from the Alpine field. Reasons for avoiding development include: (1) the concern that discharging a firearm near the various facilities and infrastructure will result in liability for damage, death to a worker, or serious environmental consequences (e.g., an oil spill from a punctured pipeline); and (2) the belief by residents of Nuiqsut that animals habituated to oil and gas infrastructure are contaminated and not safe for human consumption. As a result, the total area of any development in the planning area could be effectively removed from the traditional harvest area of a given community.

Nuiqsut hunters have already altered their hunting patterns due to nearby development and the community will likely be affected by additional development in the NPR-A earlier than other communities. This is because development in their traditional harvest area is currently in the planning stage and because at least some of the development that may occur farther west would require infrastructure to pass through their harvest area. The most likely scenario is that development will proceed west from the Nuiqsut vicinity, and hunters from the communities of Barrow and Atqasuk may eventually be affected by the expansion of industry in the northern NPR-A. Wainwright hunters would likely see fewer effects from that expansion, but development in their subsistence area of the western NPR-A could eventually be impacted by oil and gas development. Oil and gas activity in the Umiat area could affect the customary harvest of moose along the Colville River between Nuiqsut and Umiat by Anaktuvuk Pass hunters.

Effects of Abandonment and Reclamation

During oil facility abandonment and reclamation activities, which could include the removal of all equipment and facilities and the plugging of all wells, subsistence resources and activities would be subject to impacts similar to those caused by construction. Following abandonment and reclamation, these impacts would be considerably reduced. If gravel roads and pads were left in place and remained serviceable, they could be used by residents to provide access to subsistence resources, possibly reducing hunting effort and time. Gravel pads also attract caribou that are searching for insect relief (Ballard et al. 2000) and provide a measure of elevation, which hunters may use to scout for game.

Effects of Spills

Small spills (e.g., less than 500 barrels) are the most frequently-occurring spill type on the North Slope, and primarily consist of the release of less than a barrel of aviation fuel, diesel fuel, engine lube oil, fuel oil, gasoline, grease, hydraulic oil, transformer oil, and transmission oil. The assumed volume of small crude and refined oil spills over the life of the development in the NPR-A under Alternative A is 717 barrels. This estimate is quite close to the estimates for Alternatives C and D (702 and 755 barrels respectively). The estimate for Alternative B-1 is 500 barrels and Alternative B-2 is 546. For purposes of analysis, the BLM assumes that one large spill (from 500 barrels to less than 120,000 barrels) occurs from either a pipeline or a facility from each alternative if all resources are produced. A very large spill, defined as a spill greater than or equal to 120,000 barrels of oil, is considered extremely unlikely to occur.

The effects of oil spills on subsistence species would depend upon the size of the oil spill and the exact location of the spill. Spills contained on pads would likely have few impacts to subsistence species, in part because companies are required to report and quickly clean up these types of spills. Oil spills on the tundra, if they did not escape to a waterway and if they occurred on snow or frozen tundra, could affect small numbers of terrestrial mammals and waterfowl that would be unable to avoid the spill area but would be unlikely to have population-level effects. Oil spills on wet or non-frozen tundra would have some possibility of seeping into lakes and streams, and very large spills would most likely contaminate a waterway. Those oil spills that directly enter a water body, particularly under conditions that make them difficult to contain (e.g., during breakup) could spread widely and be toxic to fish and waterfowl. This situation could lead to long-term, population level effects. Any impact due to an oil spill would compound risks associated with current contamination level and subsistence users would likely harvest fewer subsistence resources due to perceived risks. If the spill were to occur on the tundra, subsistence harvesters would likely not take caribou or other consumable resources from the general area.

In the nearshore environment, a large spill, particularly when broken ice or storm conditions are present, could affect marine mammals. The Iñupiat consider contamination from oil spills in nearshore waters to be a catastrophic possibility that would threaten their very existence (Brower 1976, Itta 2001). A large oil spill into nearshore or riverine environments could cause injury or death to bowhead whales, or cause them to move off their normal course, thereby making them unavailable for subsistence harvest for Nuiqsut, Barrow, Wainwright, Point Lay, and possibly other communities. In this event, residents of both whaling and non-whaling communities would lose an important source of subsistence food and would face issues of contamination. The cost and effort to replace lost resources would increase, as would social disruption due to resource damage and the inability to participate in whaling. The loss of a major source of subsistence food would result in financial hardship. Many subsistence users would likely abstain from participating in maritime subsistence activities for a period of time in order to allow resources to recover. This could result in an increased dependence on caribou and other terrestrial resources, possibly impacting population levels in those animals. Such an event could also trigger a reduction in the International Whaling Commission subsistence bowhead whale quota, which would cause hardship for all subsistence whaling communities in Alaska, Canada's Arctic, and Chukotka.

A spill could interrupt subsistence seal hunting and fishing in riverine, lacustrine, and nearshore environments. The effects of a spill into lakes, rivers, or nearshore waters would extend beyond the margins of the spill itself, and concerns about contamination would last for many years. In Barrow, marine mammals supply from 53 to 74 percent of the total subsistence harvest by weight. Marine mammal harvests in Nuiqsut have ranged from 8 percent in a poor year to 35 percent in a more successful bowhead whale harvest year. In Wainwright, the marine mammal harvest comprises 70 percent of the annual harvest during a successful bowhead year. Atqasuk residents harvest seals and may harvest whales in cooperation with other communities, while Anaktuvuk Pass residents depend on trade for marine mammal products. A spill that affected beluga whales in the nearshore environment of the Chukchi Sea would have significant impacts on Point Lay, where beluga is the primary subsistence species.

An oil spill of any volume into a river system or lake could affect subsistence fish harvests. Nuiqsut has depended upon fish for 30 to 45 percent of its total subsistence harvest by weight (larger percentages in years when no bowheads are harvested). Barrow, Wainwright, Point Lay, Atqasuk, and Anaktuvuk Pass depend on subsistence fish harvests for varying proportions of their diet. The greatest impacts would result from a spill into lakes, rivers, or nearshore waters, particularly in key areas such as spawning and feeding areas and overwintering habitat.

The Oil Pollution Act of 1990 provides authority for creation of a Natural Resource Trustee Council following a spill that would have authority to require industry funding of monitoring of impacts to subsistence following an oil spill, remediation of such impacts, and a scientific review panel to advise the Authorized Officer on these matters.

Potential for impacts to subsistence species from small oil spills under Alternative A would be slightly lower as compared to Alternatives C and D but greater than under Alternatives B-1 and B-2. Under Alternatives A and D, nearshore environments in the NPR-A would remain available for leasing and thus the risk of spills in these critical areas is higher under these alternatives than it would be under Alternatives B-1, B-2, and C, all of which make coastal waterbodies unavailable for leasing.

4.3.13.3 Effectiveness of Stipulations and Required Operating Procedures

Many of the protective measures outlined in Alternative A are intended to ensure the continued health of subsistence resources and to promote a responsive relationship between subsistence users, the BLM, and oil and gas companies.

Alternative A provides important protective measures that are explicitly aimed at minimizing conflicts between subsistence users and oil and gas activities. Required Operating Procedure H-1 is designed to prevent unreasonable conflicts between subsistence uses and oil and gas development by requiring that, before submitting an application to BLM, a prospective lessee/permittee consult directly with affected communities to discuss the timing, location, and methods of their proposed operations. An applicant must document its consultation efforts as part of its plan of operation and must submit the plan of operations to the National Petroleum Reserve in Alaska Subsistence Advisory Panel for review and comment. An applicant must submit said plan sufficiently early to provide time for review by the Subsistence Advisory Panel and, if necessary, for Government-to-Government consultation with Native Tribal governments. Among other items, the operations plan must describe methods the applicant will use to monitor the effects of the activity on subsistence and must describe how the applicant will keep potentially affected individuals and communities up-to-date on the activities and locations of possible conflicts with subsistence users.

In addition to the consultation process detailed in H-1, Required Operating Procedure H-2 is intended to prevent unreasonable conflicts between subsistence activities and seismic exploration by mandating that an applicant for seismic exploration shall notify local Search and Rescue operations of current and recent seismic surveys and shall notify in writing all potentially affected cabin and camp users.

Effectiveness of Stipulations and Required Operating Procedures/Best Management Practices on Subsistence Species

Many of the protective measures outlined in Alternative A are intended to minimize the surface impacts of oil and gas activities and to otherwise ensure the continued health of wildlife and subsistence resources. For a complete description of the measures under Alternative A that are designed to mitigate impacts to fish, see section 4.3.7. Measures designed to protect birds are described in section 4.3.8, measures designed to protect terrestrial mammals are described in section 4.3.9, and measures designed to protect marine mammals are described in section 4.3.10. Measures that are particularly relevant to subsistence species are listed below.

- A-11 would, for all permanent development, mandate the design and implementation of a study to monitor contaminants in subsistence foods.
- Measures that minimize disruption of caribou include E-7, K-5, K-6, K-9, and K-10.
- To protect fish habitat, B-1 and B-2 regulate water withdrawals, K-1 establishes setbacks along rivers, and C-2 to C-4 protect streams and prevent additional freeze down of deep-water pools.
- K-3 minimizes disruptions to the natural qualities and functions of the Teshekpuk Lake Shoreline.
- K-3b sets significantly higher standards for oil and gas activities in major coastal waterbodies.
- K-8 protects subsistence resources and access in the Kasegaluk Lagoon Special Area.
- K-11 limits the amount of surface disturbance in the area north of Teshekpuk Lake.
- E-10 minimizes the chances that migrating waterfowl will strike oil and gas facilities during low light conditions.

Effectiveness of Stipulations and Required Operating Procedures on Subsistence Harvest Patterns

In general, the required operating procedures/best management practices and lease stipulations seek to protect specific resources by establishing spatial buffer zones around facilities and infrastructure, scheduling disruptive activities when there is the least potential for conflicts with other users, making efforts to include community residents in project planning, monitoring effects on subsistence resources, and making efforts to minimize the interference of oil and gas exploration and development activities and structures with subsistence resources and users. Under Alternative A, for example, Required Operating Procedure A-4 minimizes the impacts of contaminants on fish, wildlife, and the environment, thereby protecting subsistence resources. In the past, subsistence users have learned to avoid contaminated areas and, despite the greatly improved regulations governing waste management in recent decades, many people continue to suspect contamination from industrial developments. If A-4 is effective, this suspicion should decrease in subsequent generations. Another measure that could effectively minimize disruption to subsistence activities is Required Operating Procedure I-1, which would require lessees to provide a cultural orientation for all oil and gas workers to minimize cultural and resource conflicts with local inhabitants.

Aircraft use near traditional subsistence cabins and campsites during spring goose and fall caribou and moose hunting is a common concern. By mandating minimum flight altitudes for industry and research, Required Operating Procedure/Best Management Practice F-1 mitigates the effects of low-flying aircraft on wildlife. This is effective when practicable and when obeyed, however, it is difficult to enforce and, as mentioned above, there are three major exemptions from F-1: wildlife surveys, foul weather, and take offs and landings. Furthermore, the BLM has no authority over private aircraft or aircraft used by projects that do not have BLM permits. BLM-chartered aircraft and aircraft use by BLM permittees accounts for a small percentage of the aircraft use in the NPR-A, therefore the BLM is not able to effectively mitigate the wider problem. The BLM has implemented a system whereby subsistence users notify the BLM of problem aircraft and the BLM attempts to track down the pilots or owners of the aircraft. Nevertheless, aircraft interference with subsistence activities continues to be mentioned as a primary disturbance of subsistence activities. Several residents of Nuiqsut contend that the nuisance caused by aircraft is at such a level that they no longer support roadless development, which was previously the preferred option. According to these residents, roads and road traffic through town would have many advantages and disadvantages, but on the whole would be preferable to the high number of overflights that the community currently endures (USDOI BLM 2010).

Several measures provide specific limitations on development near subsistence sites. Lease Stipulations K-1, K-2, and K-3 would minimize impacts to subsistence cabins and campsites and disruptions to subsistence activities by prohibiting permanent oil and gas facilities (e.g., gravel pads, roads and airstrips, and pipelines) through setbacks areas around rivers, lakes, and coastal waterbodies. Lease Stipulation K-6 is intended to minimize impacts to subsistence activities from permanent oil and facilities in coastal areas by implementing, to the extent practicable, a setback of three-quarters of a mile from the coastline and by mandating the use of previously occupied sites (e.g., Camp Lonely, various Husky/USGS drill sites, and Distant Early Warning-Line sites) when possible. Other measures that are particularly relevant to subsistence harvest patterns include:

- E-1, which requires that all roads be designed to protect subsistence use and access to traditional hunting and fishing areas.
- E-2, E-3, E-6, and E-8, which maintain subsistence use and access to traditional subsistence fishing sites.
- E-7, which mandates pipeline height to provide for the safe and unimpeded passage of subsistence hunters.
- K-8 is the measure that regulates the Kasegaluk Lagoon Special Area, the objective of which is in part to protect traditional subsistence uses and public access to and through Kasegaluk Lagoon for current and future generations of North Slope residents.

The actual effectiveness of protective measures depends heavily on their ongoing implementation, on enforcement, and on the precise location of facilities and infrastructure. Effectiveness is also dependent on the sharing of local knowledge and on informed input from residents of affected communities. As described above, several measures are designed to ensure that subsistence hunters participate in plan design. However, municipal governments and tribal governments generally have limited funding and few paid staff, and members of these organizations feel overtaxed when asked to provide meaningful input to BLM on proposed or permitted activities. This institutional overload affects subsistence users by placing increased, non-compensated demands on their time, further reducing the time available for subsistence pursuits. Many such NPR-A residents contend that the change from the prescriptive lease stipulations that were put in place by the 1998 Northeast IAP/EIS to the performance-based rules put in place by subsequent IAP/EISs forces them to spend more time defending subsistence interests because compliance is now defined in terms of meeting management objectives rather than adhering to absolute standards. The contention that it now takes more time to review and to effectively respond to industry proposals was reiterated during scoping meetings in 2010 (USDOI BLM 2010).

The BLM has found that performance-based regulations provide equal protection with greater flexibility and project relevance. The flexibility of the performance-based approach places greater reliance on on-going monitoring to ensure that regulations are in fact achieving the desired level of protection. The BLM is committed to directing the resources necessary for on-going monitoring, including support for the Subsistence Advisory Panel to provide oversight, exchange information, and develop solutions for emerging issues.

4.3.13.4 Conclusion

Under Alternative A, there would be a wide range of direct and indirect impacts to subsistence resources and to access to subsistence resources. Areas of particular importance to subsistence users, including the land surrounding subsistence camps, critical habitat for subsistence species, and large concentrations of historic and prehistoric cultural resources, could be impacted by oil and gas activities. Anxiety over barriers to using these areas could increase in NPR-A communities. If oil and gas development occurs near Teshekpuk Lake and is connected by pipelines to the Alpine field, residents of Nuiqsut, Barrow, and Atqasuk may avoid what is now an important subsistence use area. If marine traffic increases in the near shore areas of the Beaufort Sea, including the barging of equipment to staging areas, bowhead whales could be deflected or their behavior made more dangerous to hunters (North Slope Borough 2004). Development in the area north of Teshekpuk Lake could impact the numbers, habitat, migration patterns, and quality of crucial subsistence foods, including caribou, waterfowl, and anadromous and amphidromous fish. Wolf and wolverine hunting is a major winter subsistence activity in the NPR-A, and subsistence users have noted that these species avoid areas of oil and gas activity.

Increased air and ground traffic at the Alpine field could divert caribou and other subsistence species away from Nuiqsut. Traffic that occurred north and south of Nuiqsut could isolate the community from subsistence resource harvest areas and could prevent residents from using their homelands, subsistence cabins and camps, and unspoiled open areas for resource harvests and pursuits.

Development in the Umiat area would affect winter subsistence users from Anaktuvuk Pass, would increase concerns over contaminants downstream in Nuiqsut, and could affect the subsistence harvest of moose along the Colville River between Umiat and Nuiqsut. Waterfowl harvests in the NPR-A could be affected, as oil and gas activity could cause migratory birds to move outside of their normal migration routes and nesting and molting areas. Subsistence hunters may have to travel greater distances to successfully harvest game, meaning that hunting will be more time-consuming, more expensive, and there will be a greater risk for breakdowns and other incidents requiring search and rescue missions farther from the community. Decreased opportunity to harvest terrestrial mammals could be especially problematic if climate change inhibits fall travel by delaying freeze up or by causing Arctic Ocean ice to retreat farther from the shore, making the harvesting of whales and other marine mammals more difficult. If harvesting marine mammals becomes more difficult, there is likely to be greater pressure to harvest terrestrial subsistence foods. Terrestrial subsistence species are precisely the resources that oil and gas development in NPR-A, particularly in the calving grounds of the Teshekpuk Lake Caribou Herd, will likely impact under this alternative. If subsistence harvests were to decrease to the point where amounts were not sufficient to share, changes in social organization and cultural values would likely result. Impacts such as these would likely degrade the physical health and the quality of life of NPR-A residents and degrade the strong Iñupiaq connection with their land and environment.

Despite many differences in attitude between individuals and communities, the continuation of subsistence hunting is of paramount importance to North Slope residents. They are fearful for their ability to carry on traditional customs and activities in their preferred locations without interference and for their ability to pass along these traditions to their children. Under Alternative A, the potential for oil and gas development in the NPR-A exists and, if subsistence resources are significantly impacted by those activities, the fears of North Slope residents could be realized.

4.3.14 Sociocultural Systems

The social and cultural effects of this plan would take place against a backdrop of other continuing social effects caused by both oil development and the ongoing adaptation of Iñupiaq residents to changing social, political, technological, and economic factors associated with the rapid introduction of hunter-gatherers to modern technical and industrial society (USDOI BLM and Minerals Management Service 2003a). The primary aspects of the sociocultural systems covered in this analysis include cultural values, social organization, and social health, as described in section 3.4.4, Sociocultural Systems in Volume 1. Many Iñupiat are mobile between the various North Slope regions, have lived in several communities over their lifetimes, and maintain extensive and strong kinship ties between communities. Because Iñupiaq cultural values and social organization transcend individual communities, effects on social organization and cultural values associated with oil and gas development in one limited area (e.g., increased population and employment, changes in subsistence harvest patterns) could be experienced at the family, community, and regional levels.

Any statements or generalizations made here on sociocultural systems, cultural values, and social health are offered with strong caveats. Although the six NPR-A communities (Nuiqsut, Barrow, Atqasuk, Wainwright, Anaktuvuk Pass, and Point Lay) have many similarities and are either located within the boundaries of NPR-A or are significantly impacted by NPR-A activities, there are numerous important differences between them. These differences are largely due to the historical context, geographic location, economic situation, and leadership trends of each community. Although the value placed on subsistence activities and distribution is consistently strong throughout the North Slope, these differences have created divergent attitudes towards oil and gas development and other issues, which preclude any comprehensive summary of perspectives. Furthermore, understandings and opinions about cultural values and the sociocultural impacts of oil and gas activities are highly individualized, regardless of a person's home community.

4.3.14.1 Activities Not Associated With Oil and Gas Exploration and Development

Non-oil and gas activities include the use of aircraft and watercraft, scientific research and data collection, recreation, overland moves, and solid and hazardous waste removal and remediation. Most of these activities would be of short duration and would occur in limited areas. Research and data collection could result in the diversion or deflection of subsistence resources where helicopter or fixed-wing aircraft were used, which could result in local and temporary disruption to subsistence harvests of these resources. These localized and temporary effects would be unlikely to affect sociocultural patterns in North Slope communities. Archaeological research could increase interest in Iñupiat cultural history, although some residents may oppose archaeological research for spiritual reasons or for fear that Iñupiat artifacts and history will be exploited by outsiders. Social and anthropological research on land use, place names, sharing systems and subsistence trends – especially projects undertaken in collaboration with hunters – could produce maps and other products that enrich awareness of the land. Recreational uses, primarily rafting and bird watching, would generally occur during the summer along rivers such as the Colville and Ikpikpuk and would create localized and temporary effects (e.g., user conflicts and subsistence resource deflection) that would persist as long as those users were in the area. Overland moves supply communities with bulky goods and fuel and are sometimes necessary to move scientific and other camp equipment during the winter. Such moves occur during the winter using low ground pressure vehicles and are subject to the restrictions placed on these activities in the lease stipulations (USDOI BLM and Minerals Management Service 1998). Effects from overland moves would be temporary and would be unlikely to affect overall sociocultural patterns.

4.3.14.2 Oil and Gas Exploration and Development Activities

Effects of Disturbances

An analysis of cultural values involves examining those values shared by most members of a social group. Iñupiaq values in large part originate from and are sustained by subsistence activities and uses that include sharing, transfer of knowledge, satisfaction of eating traditional food, integrity of culturally important places, and autonomy. Effects on cultural values could result from fundamental cultural changes imposed or induced by external forces, such as when a series of fundamental technological inventions change existing physical and social conditions or when an incoming group causes acculturation of the residing group. To the extent that outside influences come into conflict with Iñupiaq values and subsistence activities, they conflict with core Iñupiaq values and produce sociocultural consequences. Such changes in cultural values can occur slowly and imperceptibly, or suddenly and dramatically (Lantis 1959, Chance 1990). In this sense, cultural values are a standard against which change can be compared. The impending change could allow greater opportunities for Iñupiat to realize their values and goals, or it could constrain and restrict the realization of these values and goals. In general, modernization in Inuit societies has been associated with the displacement of traditional subsistence-based sociocultural systems (Shephard and Rode 1996, Curtis et al. 2005).

Years of statements by residents during public meetings for BLM and Minerals Management Service oil and gas lease sales relate the concerns, anxiety, and apprehension felt by locals regarding oil and gas activity, especially with regard to the lack of control they feel over what is happening on their traditional lands. Additionally, as described in more detail in section 3.4.21, existing public health data on indicators of social stress (i.e., suicide rates, the prevalence of domestic violence, the rates of injury related to alcohol and substance abuse) and studies on the etiology of these problems in Arctic communities suggest pathways through which industrial activity would be likely to impact social health.

Although previous sections (3.4.3 in Volume 1, 4.3.13 on page 287 of this volume) have focused on subsistence in the NPR-A and potential impacts to it from development, subsistence cannot be separated from a discussion of Iñupiaq sociocultural systems and is therefore a consistent theme throughout this section as well. Subsistence activities are an important vehicle through which culture, values, and language are passed on to the next generation. It is also through the subsistence harvest that successful hunters are able to engage in the sharing of meat, a tradition that is a strong, significant, and enduring part of Iñupiaq culture and that is key to the cohesiveness of families and communities (Okada 2010). Subsistence is part of the local economy in the NPR-A and has been directly linked to specific issues such as reduction in crime and substance abuse. For these and other reasons, subsistence is an inherent component of cultural values, kinship, and social health.

Effects on Cultural Values

In 1979, Brown stated in Nuiqsut Paisangich:

> Today, as in the past, subsistence harvest of wild resources is the central occupation of traditionalist Iñupiat. Most of the people in Nuiqsut and other northern Alaska villages are traditionalists. Despite their acceptance of many elements of Euro-American culture, technology and economy, these people continue to participate in and depend on the subsistence way of life, either as hunters or as sponsors and sharers of the hunt. Subsistence provides such necessities as food and clothing, and it organizes the people's lives seasonally, socially, and ceremonially in the defining patterns of their culture.

Thirty-two years after Nuiqsut Paisangich was published, such statements are remarkably appropriate if no longer completely accurate. Approximately 61 percent of the North Slope Borough's population has been born since 1976 and the largest age cohort is under 5 years (AK Dept. Labor 2011). Few people depend on subsistence resources for clothing other than parka ruffs, mukluks, and ceremonial garments. The core of Iñupiaq cultural pride and identity remains subsistence food: hunting for, sharing, and consuming it. However, younger people enjoy an increasingly limited variety of subsistence foods, many participate in few subsistence activities, and their lives are at least as organized by the school season. People of all ages share and rejoice in a modern Iñupiaq Pride movement over social networking sites using tablet computers and smart phones. Many NPR-A residents are as concerned about a stable economy for future generations as they are about subsistence.

Potential negative sociocultural effects associated with the oil and gas exploration activities and development scenarios associated with Alternative A include, but are not limited to, changes in social cohesion; changes in social interaction within and between communities; increases in suicides and violent crimes, high risk behavior and substance abuse; and decreases in cultural transmission between youth and elders (USDOI BLM and Minerals Management Service 1998, 2003b). These problems are also discussed in detail in section 4.3.21, "Public Health." It is increasingly recognized by Iñupiaq leaders that encouraging subsistence activities is the most successful method of solving problems of crime, particularly among young Iñupiaq men. Many young men leave their communities to live in larger cities and often thrive there, while others acquire criminal records and experience racism, greater levels of social or cultural separation resulting in feelings of "not belonging," and other problems. However, this encourages many to return to their home villages where they can emerge as leaders and successful hunters in that environment. A subsistence lifestyle is very commonly the way that North Slope residents keep themselves and their family members sober. Anthropologists with experience in Alaska have speculated that Native Alaskans who suffer from alcoholism have greater success rates for quitting "cold turkey," even without support groups such as Alcoholics Anonymous, because they have a strong subsistence lifestyle to which they can devote themselves. It is common for subsistence camps to be alcohol free and a place where people who drink stay sober for longer periods of time than they normally do in town. To the extent that oil and gas activities under Alternative A would inhibit residents from spending time at traditional camps by allowing new development to hinder access to or encroach on subsistence use areas, or otherwise exacerbate the focus on the cash-based economy as opposed to the egalitarian sharing network, it could impact this cultural response to troubled residents (Calloway 2010).

The Iñupiaq language is an important cultural transmission between youth and elders that would decrease if the subsistence lifestyle were diminished. Although the Iñupiaq language is technically declining in use on Alaska's North Slope, its demise is strongly inhibited by language revitalization movements and by the amount it is spoken during hunting trips and at subsistence camps where situations and activities are described or discussed in Iñupiaq or in English replete with Iñupiaq words. Younger generations' knowledge of Iñupiaq is particularly enhanced through subsistence activities because place and animal names, hunting and boating terminology, and other words for subsistence activities are acquired more easily when people are immersed in those activities. To the extent that Alternative A would exacerbate the trends associated with modernization of decreased time spent participating in subsistence activities and an increased focus on the nuclear family as opposed to the extended family structure that is more likely to include Iñupiaq-speaking elders, it could negatively impact the transmission of the Iñupiaq language.

Effects on Social Organization

As discussed in section 3.4.4, "Sociocultural Systems" (Volume 1) and above, the social organization of Iñupiat communities is strongly based on kinship and relationships between extended families. Kinship defines the sharing network, which is inherent to subsistence use, and comprises the foundation for community decision making and well-being. The inherent resilience of the sharing network to adapt to changing conditions and harvests has allowed the Iñupiat to remain successful for thousands of years. However, oil and gas activities that result in significant impacts to subsistence harvest (i.e., displacement of resources during exploration, construction and operation or avoidance of subsistence use areas where production facilities have been constructed) have the potential to disrupt the customary sharing networks both within and between communities, especially if harvests were impacted in successive years.

Social organization on the North Slope centers on group subsistence activities and on an extensive network of families and individuals who share subsistence resources. For the system of sharing to operate properly, some households (known as "super households") must be able to consistently produce a surplus of subsistence goods. For this reason, it is not simply harvest and consumption rates that are sensitive to harvest disruptions, but the wider systems of sharing and the supply of subsistence foods in the sharing network. In rural Alaska Native communities, cooperative task groups associated with subsistence harvests are important in defining social roles and kinship ties. The distribution of specific tasks also reflects and reinforces the roles of husbands, wives, grandparents, children, friends, and others (USDOI BLM and Minerals Management Service1998, 2003b). Generally, social groups are based on kinship and marriage systems, as well as on nonbiological alliances formed by characteristics such as age, sex, ethnicity, community, and personality. Kinship relations and nonbiological alliances serve to extend and ensure cooperation within the society. The interdependence of individuals within social and family kinship networks is known as "social capital." Measures of social capital tend to be high in subsistence-based cultures and are associated with increased well-being and improved physical health (Wilkinson and Marmot 2003). Put simply, Iñupiat count family as wealth and believe that the more people involved in a family's extended network of hunting and sharing, the better life is for everyone in that extended group. Disruption of subsistence harvest task groups would conflict with cultural values, would damage the social bonds that hold the community together, and would reduce social capital. This could trigger an array of negative emotions such as fear, anger, and frustration, as well as a sense of loss and helplessness.

Effects on Social Health

Under Alternative A, industry would stage oil and gas activities at previously industrialized facilities (Prudhoe Bay, Kuparuk, Point Lonely and other Distant Early Warning-Line sites) whenever possible. In the past, these sites have been distant from communities and disruption has been an infrequent issue. However, many residents of Nuiqsut would prefer that oil field workers be forced to come through their community on roads so that Nuiqsut can at least make some profit off the disturbance they experience.

Historically, increased interaction with outside workers has resulted in increased access to urban communities, the introduction of new values and ideas, increased racial tensions, and an increased availability of drugs and alcohol. A large influx of outside oil and gas workers would almost certainly create some level of disturbance and a mixture of positive and negative effects for a community. However, those disturbances and intercultural relations will be different and muted today because the North Slope has an increasingly ethnically integrated and cosmopolitan society, as well as an increasingly globalized economy. In the past, outside workers did introduce media that broadcast new values and ideas (i.e., movies shown at Distant Early Warning-Line sites, beginning in the 1950s, spread ideas about the Cold War). Today, radio, television, and internet are already available in communities located in the NPR-A and even a few remote subsistence cabins have satellite dishes. Many Wainwright residents are pleased that oil and gas activity in their town to date has meant that more jobs and modern services are available. For example, Wainwright had EDGE digital mobile phone data technology years earlier than Barrow. While it is true that, in the past, large amounts of alcohol were available in North Slope communities due to oil contractors and military sites, the transport of drugs and alcohol into NPR-A communities today is not directly dependent on outside workers; instead, its levels appear to be influenced more by the amount of disposable income residents have. The size of dividends, a common source of disposable income in rural Alaska, has been connected to oil and gas activity; therefore, periods with more outside workers may be concomitant with periods of higher dividend payouts and spikes in drug and alcohol use. In the past, influxes of outside workers (overwhelmingly male) have created some resentment on the part of local men due to competition over relations with local women and there have been instances of unwanted pregnancies, fatherless children, and women marrying outsiders and leaving the community. These issues may still exist; however, there currently appears to be a high level of separation, acceptance, and indifference between most residents and workers. Under all alternatives, it is estimated that an influx of oil and gas workers today would represent a negligible fraction of the overall impact from modernization and the global economy.

One type of disturbance that could accompany a local boom in industry is an increase in income disparity as the relatively few families whose members secure permanent employment or are otherwise positioned to benefit more directly from oil and gas activities are noticeably better off financially than their neighbors. However, very few Iñupiat have been directly employed in oil production facilities. In spite of low local hire levels, other jobs made possible by North Slope oil revenues - in addition to infrastructure, safety, medical care and education opportunities - have significantly improved the quality of life and social health of NPR-A residents. As detailed in section 3.4.11, “Economy” in Volume 1, the North Slope Borough is a regional market economy based almost exclusively on the petroleum industry (oil property taxes), it is the main employer and provider of public services in the region, and it has few opportunities for diversification. To the extent that BLM management decisions made in conjunction with this IAP/EIS will affect oil and gas development, they will affect that economy; the North Slope Borough needs development in the NPR-A in order to make up for revenues that are decreasing from other areas of the North Slope. However, BLM management in the NPR-A is unlikely to change the broader trend, which is that the Arctic oil boom peaked in Alaska in 1988 and has since shifted to other areas of the Arctic. The eventual development of a natural gas line and/or offshore oil development could mitigate the economic impacts of that trend. One existing source of revenue is the Arctic Slope Regional Corporation, which, as the largest Alaskan-owned company, is extremely diversified and is an active participant in the global economy. In 1989, Arctic Slope Regional Corporation added individuals born after 1971 as shareholders and now has approximately 11,000 shareholders. Arctic Slope Regional Corporation dividends are significant sources of income: since its inception, the company has distributed over $400 million in dividends. In addition to dividends, employment and education benefits have been extended to shareholders (Arctic Slope Regional Corporation 2011). Although the success of Arctic Slope Regional Corporation will mitigate a downturn in local economy, the current standard of living for North Slope residents (already lower in real terms than the rest of the U.S.) will be impossible to maintain unless significant external sources of local revenue are found.

Alternative A will likely have sociocultural impacts for the communities of Nuiqsut and Wainwright, although not all impacts will necessarily be negative. Both communities have experienced significant economic boosts due to oil and gas activity in their regions. Wainwright is currently experiencing economic benefits, which are boosting subsistence activities because more families have been able to purchase boats, outboard motors, propellers, ammunition, and fuel to go hunting.

Nuiqsut has experienced economic advantages from regional oil development for a longer period of time, but the residents also live with the disadvantages of trying to hunt in an area largely surrounded by oil and gas development. Nuiqsut is the community in closest proximity to oil and gas development activity. Many Nuiqsut residents have stated during scoping meetings that they are being affected by oil and gas development and related activities enveloping the community from the east and excluding them from preferred subsistence harvest areas (Ahtuangaruak 2001; Kunaknana 2010). As noted in section 4.3.13, Subsistence, some Nuiqsut residents do not feel that they have received impact funds or other compensation in proportion to the negative impacts they have experienced from nearby development. Some residents of Nuiqsut claim that the influence of industry has corrupted community governance, breaking down the system of checks and balance that should exist between the tribal government, the city government, and the village corporation. Many Nuiqsut residents also express the concern that their social lives have been increasingly dominated by industry-related meetings and presentations where attendance is largely encouraged by the chance of winning door prizes. These meetings have overshadowed events, which draw the community together for the sake of community. This situation appears to be increasingly true in Wainwright as well.

Oil and gas development in the central and southern portion of the northeast section of NPR-A could further surround the community of Nuiqsut and increase the difficulty, expense, and risk of traveling to desired subsistence harvest areas. This development could also divert subsistence users for a distance of 5 to more than 25 miles from facilities (see section 3.4.3.4, "Subsistence User Avoidance of Developed Areas" in Volume 1). This would decrease the use of traditionally used lands by reducing access to these lands and lowering the quality of the experience of and connections to the land for Iñupiaq users. This disconnection from traditional uses threatens the subsistence way of life that is a major component of Iñupiaq culture. Nuiqsut residents observe direct connections between the general well-being of their community and subsistence harvests (Ahtuangaruak 1997). To the extent that oil and gas activities conflict with ongoing subsistence activities, they conflict with Iñupiaq cultural values.

A shift in Nuiqsut's most heavily used subsistence areas may have regional sociological impacts. Relations in areas of overlapping subsistence use by residents of Nuiqsut, Atqasuk, and Barrow are relatively smooth, but there is a risk that that could change if Nuiqsut users are increasingly forced into the traditional and more exclusive subsistence use areas of other communities.

Under Alternative A, Atqasuk could also be affected by oil and gas activity in the Teshekpuk Lake area if said activity diverted or deflected the Teshekpuk Lake Caribou Herd from their normal migration routes. This would increase the difficulty, expense, and risk of traveling to subsistence harvest areas. As a result, there would be an increase in social stress, as hunters would leave the community for longer periods to harvest resources, and potentially experience less successful hunts. Indirect effects could include increased competition for subsistence resources with other communities, a change in subsistence emphasis to other resources (e.g., sheep, moose, and fish), decreased self-sufficiency, and changes in relations with other Iñupiat communities.

Under Alternative A, large areas south of Teshekpuk Lake that are a subsistence harvest area used by Nuiqsut, Atqasuk and Barrow for wolf and wolverine hunting, caribou harvests, and fishing would be available for year-round occupation and development. The area around Teshekpuk Lake was relatively densely populated in recent historic times. Many elders now living in Barrow and Nuiqsut were raised in small camps in that region and still consider it their true home. Oil and gas exploration and development in these areas could alter subsistence harvests in these areas, thus affecting cultural values such as transfer of knowledge between elders and youth related to those areas; the integrity of culturally important places; and the importance of hard work, cooperation, and sharing. Some areas with traditional importance to families, such as camps and cabins used by many residents for fishing and caribou and waterfowl hunting, would be protected by Required Operating Procedure H-2 and stream and lake setbacks. This is consistent with the high value the Iñupiat place on these locations.

Effects of Abandonment and Reclamation

At present, very few NPR-A residents have jobs in the oil fields (Circumpolar Research Associates 2002). Abandonment and reclamation activities would likely generate jobs for local residents for several years and at greater levels of employment than would exist during the operational phase. If local residents were to become substantially integrated into oil field operations, their families could face economic difficulty as fields were abandoned and rehabilitated. North Slope communities, due to the support of the North Slope Borough, are already dependent on revenues associated with oil development. If no oil fields were active in the area to provide jobs and contribute economically to the local economy and government revenue, the region could face a time of economic depression, which is associated with increased social pathology in Iñupiaq communities, as discussed in section 4.3.21. The Arctic Slope Regional Corporation dividends, which are less dependent on local resource development, could provide some mitigating financial support if oil and gas revenues decrease. However, no potential avenues for maintaining income and borough funding at the levels established in the oil development era have been identified. Abandonment and reclamation activities would restore habitat for caribou and other subsistence species and subsistence resources would thereafter be subject to fewer impacts, potentially improving subsistence opportunities.

Effects of Oil Spills

Small spills that remain on land and do not spread to fresh water or marine environments would likely have a minor effect on overall sociocultural patterns. Large spills, if contained on land, could disrupt subsistence harvests, as hunters would likely avoid contaminated resources and would not participate in traditional subsistence activities in contaminated areas. This decrease in participation could increase the cost and effort of harvesting uncontaminated resources, or lead residents to depend on store-bought food.

A large oil spill into a river, lake, or marine environment prior to breakup could contaminate a wide area with crude oil. Oil spills in these environments could affect fish and marine mammals, and many residents would harvest fewer of these resources. Effects on subsistence and sociocultural responses, similar to those that occurred after the Exxon Valdez oil spill, could result from the unlikely, but possible, release of large volumes of crude oil in the planning area (Fall et al. 2001). If oil spill contamination concerns or clean-up activities were to result in the suspension of whaling, then Barrow, Nuiqsut, Wainwright, Atqasuk, Point Lay, and other whaling communities would be directly affected for the duration of the suspension, as whaling is the basis for most social organization and interaction in those communities. The Iñupiat believe that a large marine oil spill would injure or kill large numbers of whales, especially during the spring migration when whales and spilled oil would concentrate in open leads (National Research Council 2003). In addition, the Iñupiat fear that the International Whaling Commission would reduce or curtail whaling quotas due to the increased threat to bowhead whales following a spill (Napageak 1990; National Research Council 2003). A reduction in International Whaling Commission bowhead whaling quotas on the North Slope would result in negative subsistence, economic, cultural, and social impacts throughout the region. Whaling is important to the Iñupiat for both subsistence and cultural purposes. Organization of whaling crews and preparations for the hunt reinforce social and cultural bonds, and processing the whale often involves a large portion of the community. Therefore, disruptions to the bowhead whale hunts would affect social organization and add to social stress. Sharing of the whale is a valuable part of the Iñupiaq culture, and a loss of this resource would affect cultural values and Iñupiaq well-being. A large oil spill into a riverine, lacustrine, or marine environment prior to breakup could indirectly affect Anaktuvuk Pass due to a decrease in bartered subsistence foods from other North Slope communities.

Other industrial activities associated with oil development that could have an effect on sociocultural systems would be those associated with cleanup if an oil spill did occur. In the event of a large spill that contacted and oiled habitats, the presence of hundreds of humans, boats, and aircraft would increase the displacement of subsistence species and alter or reduce access to subsistence species by subsistence hunters. Because oil spills are usually minor events that would normally be contained on the drill pad, effects from small spills and chronic potential disruption from clean-up activities are not likely to cause great disturbance to sociocultural systems or the surrounding environment.

4.3.14.3 Effectiveness of Stipulations and Required Operating Procedures

Alternative A, the no action alternative, extends the performance-based lease stipulations and required operating procedures that were put in place by the 2004 Northwest NPR-A IAP and the 2008 Northeast NPR-A (USDOI BLM 2004, 2008) to the entire NPR-A.

Because subsistence is an inherent component of cultural values, kinship, and social health, the description of the measures under Alternative A that are relevant to subsistence species and subsistence access (section 4.3.13.3) is also applicable to this summary of sociocultural impacts.

Required Operating Procedure H-1 provides opportunities to affected communities for participation in planning and decision making to prevent unreasonable conflicts between subsistence users and oil and gas related activities. Required Operating Procedure/Best Management Practice I-1 requires lessees to provide a cultural orientation program for all oil and gas personnel involved in NPR-A activities in order to minimize cultural and resource conflicts with local inhabitants. This orientation program, as it relates to subsistence pursuits and cultural concerns, would: (1) provide sufficient detail to notify personnel of applicable lease stipulations and ROPs, as well as inform them about specific types of environmental, social, traditional, and cultural concerns that relate to the region; (2) address the importance of not disturbing archaeological and biological resources and habitats, and provide guidance on how to avoid disturbance; (3) be designed to increase sensitivity and understanding of personnel to community values, customs, and lifestyles in areas where personnel would be operating; (4) include information about avoidance of conflicts with subsistence, commercial fishing activities, and pertinent mitigation; and (5) include information for aircraft personnel concerning subsistence activities and areas and seasons that are particularly sensitive to disturbance by low flying aircraft (e.g., aircraft use near traditional subsistence camps and cabins, flights during spring goose hunting and fall moose hunting seasons, and flights near North Slope communities).

4.3.14.4 Conclusion

Effects on sociocultural systems under Alternative A would be due to effects on subsistence harvest patterns, changes in employment and population, and effects on public health. To the extent that Alternative A increases revenues for the North Slope Borough, it will have a positive impact on social health in the NPR-A communities. However, to the extent that it limits use of culturally important subsistence areas, it will have a negative impact on social organization, on several Iñupiaq core values, and on some non-economic aspects of social health. In the short term, Nuiqsut is the community most likely to experience greater restriction of subsistence use areas under Alternative A. Anaktuvuk Pass subsistence users will likely avoid the Umiat area if development occurs there as planned, although this represents less of a direct impact for them than Nuiqsut is facing in its region. Because the entire southern NPR-A would be unavailable for leasing under Alternative A, cultural resources important to the communities of Point Lay and Wainwright would be protected as would the biologically critical habitat for the Western Arctic Caribou Herd, an important resource for over forty Alaskan communities. Alternative A would likely strike the same balance between economic benefits and subsistence protections that has been in place in the NPR-A in recent years. Alternative A does not offer additional special protections to areas that are considered critically important to subsistence. The lease stipulations and required operating procedures that would be in place under Alternative A have been effective at mitigating impacts to subsistence lifestyles and, within the larger context of modernization, have allowed Iñupiaq sociocultural systems to coexist with development.

4.3.15 Environmental Justice

Executive Order (EO) No. 12898 of February 1994 is “intended to promote nondiscrimination in federal programs substantially affecting human health and the environment, and to provide minority communities and low-income communities access to public information on, and an opportunity for participation in, matters relating to human health and the environment.” EO 12898 requires that federal agencies collect and analyze information on human health and subsistence effects and use this information to “determine whether their programs, policies, and activities have disproportionately high and adverse human health or environmental effects on minority populations and low-income populations.”

U.S. Environmental Protection Agency guidelines for evaluating the potential environmental effects of projects require specific identification of minority populations when either: (1) a minority population exceeds 50 percent of the population of the affected area; or (2) a minority population represents a meaningfully greater increment of the affected population than of the population of some other appropriate geographic unit, as a whole. Council for Environmental Quality (CEQ) guidance on implementing EO 12898 suggest that to accomplish these goals, “Agencies should consider relevant public health data and industry data concerning the potential for multiple or cumulative exposure to human health or environmental hazards in the affected population.” The CEQ further recommends that agencies specifically solicit input from local public health agencies and experts.

An extensive effort was made to provide all interested parties in the project vicinity with access to public information and opportunities to participate in the review process for this IAP/EIS (see section 3.4.5, "Environmental Justice" in Volume 1 and Chapter 5, "Consultation and Coordination" in Volume 5). An informational letter was sent to individuals, organizations, federal, State, and local agencies, and Alaska Native groups describing the proposed planning effort and requesting comments. Similar notices were published in newspapers in the area. Several meetings were held on the North Slope to solicit local community input early in the process, at Subsistence Advisory Panel meetings, and at the public meetings and ANILCA subsistence hearings after the Draft IAP/EIS was released. Every effort was made in the public consultation process to ensure that access to information was available to all interested parties in a non-discriminatory manner.

Subsistence activities in the planning area are important for providing dietary sustenance, and contribute to the health and well-being of North Slope residents. As a consequence, impacts to subsistence resources and access to those resources have a direct relationship to the analysis of whether the alternatives would have a disproportionate effect on minority and low-income populations.

4.3.15.1 Activities Not Associated With Oil and Gas Exploration and Development

As noted throughout this document and particularly in sections 4.3.13, "Subsistence" and 4.3.21, "Public Health," the non-oil and gas activities likely to occur in the planning area would primarily be transitory in nature, of short duration, and highly localized. The effects of these activities on subsistence resources would be to temporarily divert or disturb subsistence species from their normal movement patterns or activities. Consequently, there could be an effect on the subsistence hunting activities of the local minority population as a result of non-oil and gas activities. These effects would be minor, temporary, short-term, and generally highly localized. The effects on health, as described in section 4.3.21.1, would likely be sporadic and limited to impacts on individuals or families as opposed to impacting the health of the minority population.

4.3.15.2 Oil and Gas Exploration and Development Activities

Effects of Disturbance

Under Alternative A, oil and gas activities could have long-term effects on several terrestrial mammal species, although the effects would be localized in nature. Infrequent and localized effects on waterfowl harvested for subsistence could also occur. Onshore oil and gas activities would be expected to have little or no effect on marine mammals, but noise and disturbance associated with offshore barge and vessel traffic could impact bowhead whale migration patterns under Alternative A. There are concerns that, depending on the particular activity and, especially, the location of the activity, actions occurring under Alternative A could cause widespread effects on fish, perhaps to the level of affecting populations. All of these effects would be experienced primarily by the subsistence-dependent minority Iñupiat.

Section 4.3.21.1 indicates that there could be substantial impacts to human health under Alternative A. These impacts could occur as a result of potential restrictions in subsistence harvest and consumption, new access routes to communities, sociocultural and economic change, altered employment, and emissions. Diabetes, hypertension, and related metabolic disorders would be expected to increase as subsistence is curtailed or as sociocultural changes lead to alterations in dietary patterns. These health outcomes would be mitigated by measures, which protect subsistence, but as displacement of fish, caribou, and potentially whales are still anticipated, mitigation would not be entirely effective. Cancer, lung disease, endocrine disruption, and neurodevelopmental delay are related to contaminants common to oil and gas development. However, the existing data, though incomplete, are reassuring as to present levels of contaminants. Social pathology could also result from the anticipated economic changes, increased access to drugs and alcohol, and from stress.

Effects of Abandonment and Reclamation

Activities associated with dismantling and removing production pads and facilities could disproportionately impact NPR-A residents (most likely in Nuiqsut) through disturbance, displacement, and mortality of subsistence resources, through subsistence users' avoidance of areas undergoing dismantlement and removal, and through potential impacts to water and air quality, and noise. Once abandonment and reclamation were completed, Nuiqsut residents would be disproportionately impacted by the reduction in local corporation and North Slope Borough revenues and by fewer local jobs and business opportunities. Since economic depression is associated with increased social pathology, this could result in increases in domestic violence, injury, drug and alcohol problems, and suicide. As described in section 4.3.14, "Sociocultural Systems," the local economy is almost entirely dependent on oil and gas revenues although the globalized economies of Native corporations could limit the extent of economic depression in the NPR-A. Local residents could benefit from a reduction in impacts on subsistence resources, compared to during construction and operation. Anthropologist Robert Spencer (Spencer 1959) observed in the 1950s in Barrow that an economic depression following a boom actually led to a re-strengthening of traditional sharing and other communal practices. While it is highly speculative that 21st century sociocultural shifts would resemble those of historic times, a strong and proud belief in the ability of North Slope communities to sustain themselves if the situation demanded it exists and contributes to Iñupiaq cultural resilience.

Effects of Oil Spills

The effects of oil spills on subsistence species would greatly depend upon the size of the oil spill and the environment in which the oil spill occurred. Tundra oil spills could affect small numbers of terrestrial mammals and waterfowl unable to avoid the spill area, but would be unlikely to have population level effects. Oil that spilled directly into a water body, particularly under conditions such as breakup or broken ice, could spread widely and have long-term, population level effects on fish and waterfowl. In the nearshore environment, a large to very large spill, particularly during broken ice or storm conditions, could affect marine mammals including seals, and beluga and bowhead whales.

The Iñupiat consider contamination from oil spills in nearshore waters to be a catastrophic possibility that would threaten their very existence, primarily because of the potential effects of spills on bowhead whales, which are a very important part of their culture in addition to being a favored food source (Brower 1976; Itta 2001). These effects include acute or chronic toxicity to whales or their prey. Thus, a major oil spill would result in effects that would impact Iñupiat subsistence users more than other human groups. Oil spills can also be associated with toxicological health effects in human populations, as outlined in section 4.3.21. Furthermore, if a large spill resulted in a substantial decrease in consumption of subsistence foods, food insecurity and hunger as well as diabetes and related metabolic disorders could increase.

4.3.15.3 Effectiveness of Stipulations

Many of the lease stipulations outlined in the records of decision for the 2003 Northwest NPR-A IAP/EIS and the 2008 Northeast Supplemental IAP/EIS (USDOI BLM 2004, 2008) are designed to ensure the continued health of subsistence resources and wildlife. Oil and gas development is subject to continuous improvements in methods, and each new generation of technology improves safety and reliability. Many of the lease stipulations reflect knowledge gained from past mistakes and reflect a desire by the BLM to safeguard wildlife and subsistence resources from harm. Lease Stipulation H-1 calls for consultation with affected communities, which would help include residents in the processes that could change subsistence harvest activities in those communities.

Lease stipulations to protect subsistence species should aid in keeping those species available to subsistence users by maintaining population numbers. The management goal of other lease stipulations would be to prevent oil and gas activities from harming or disturbing subsistence resources.

4.3.15.4 Conclusion

Although exploration programs have declined to near zero in recent years, several lease sales have already taken place in the planning area and the BLM's latest lease sale was in December 2011. Residents of Barrow, Nuiqsut, and Atqasuk have noted some effects on subsistence from the seismic testing and ice pads and roads associated with exploration (Stephen R. Braund and Associates 2003a, b). One effect included the redistribution of caribou, wolves, and wolverines in response to seismic activity and cat trains operating in the NPR-A. While these effects could continue under Alternative A, there are no current proposals for seismic and most effects of disturbance would be localized, short-term, and relatively minor. Although under Alternative A the overall amount of area available for leasing (57 percent of the NPR-A) is the least of all alternatives, that is largely because the entire southern NPR-A is unavailable under Alternative A. However, the entire southern NPR-A has low potential for economically recoverable oil and gas. In terms of the amount of area available for leasing in areas where there is a high or medium potential for oil and gas, Alternative A has less than Alternative D but significantly more that Alternatives B-1, B-2, and C. Likely effects to subsistence resources, therefore, should be less under this alternative than under Alternative D but more than under Alternatives B-1, B-2, and C. Effects from oil spills would depend greatly on the size, location, and season of the spill. Small spills on gravel pads would have little or no environmental justice effects. A major spill into a watercourse, on the other hand, could have long-term serious effects on Iñupiaq subsistence activities. While any major spill would have serious consequences, the worst, from an environmental justice standpoint, would be one that occurred in a key harvest area or near a community.

The activities under Alternative A could also have substantial health effects, as outlined above and discussed in detail in section 4.3.21. Because the population within and near the planning area is primarily comprised of Iñupiat, any health effects that occur would disproportionately affect this minority population.

4.3.16 Recreation Resources

This section describes potential impacts to recreation uses of public lands under each of the alternatives. For the purpose of this analysis, short-term impacts are those that are mitigated or removed in 5 or fewer years. Long-term impacts are any impacts that last for longer than 5 years. Seasonal impacts are those that are present for a single work season either winter or summer. The impacts that are being analyzed are based on the scenarios discussed in section 4.2. When characterizing impacts to recreation resources in the NPR-A it is common to calculate impacts in terms of impact areas, usually the direct area of surface disturbance plus a 1- or 2-mile zone around the disturbance depending upon the nature of the disturbance where recreation could occur. One- and two-mile impact areas are calculated from information found in Table 4-14 of section 4.2.

Impacts from oil and gas and non-oil and gas activities affect recreation resources, settings, experiences, and ultimately, the desired beneficial outcomes from uses on public lands, including hunting, fishing, and trapping; wildlife viewing; camping; rafting; backpacking; and hiking. Impacts may be beneficial if they increase recreation opportunities, contribute to better recreation experiences, or ultimately increase realized beneficial outcomes from recreation use of the public lands. Impacts may be negative if they decrease recreation opportunities, contribute to degraded recreation experiences, or ultimately decrease realized beneficial outcomes. As stated in Chapter 3, the typical recreation activity in the Reserve takes place in non-winter months. Winter activities such as snowmachining, dog sledding, and possibly cross-country skiing can occur, but very infrequently.

There have been no studies conducted in the NPR-A to determine the benefits that recreationists are seeking in the Reserve. The BLM does have data on the number of permitted users under special recreation permits that the Arctic Field Office has issued in the NPR-A.

Alternative A – Alternative A would continue to allow leases to be offered for oil and gas exploration and development on 57 percent of NPR-A subsurface lands. Another 1.57 million acres would remain deferred from oil and gas leasing until 2014; and 425,000 acres deferred until 2018. There are 8.3 million acres that would remain as special areas (Teshekpuk Lake Special Area, Colville River Special Area, Utukok River Uplands Special Area, and Kasegaluk Lagoon Special Area). Alternative A does not recommend any rivers for wild and scenic river status.

4.3.16.1 Activities Not Associated with Oil and Gas Exploration and Development

Under Alternative A, impacts to recreation resources could result from on-the-ground management activities, such as archaeological collection efforts, field camps, survey work, overland movements, recreation permits, film permits, and hazardous and solid material removal and remediation activities.

Temporary structures such as tents, vehicles such as Rolligons, noise from generators, aircraft, human presence, and associated activities could have some minimal seasonal impacts on the setting, experiences, and desired beneficial outcome from use of public land for recreation. These seasonal impacts would be confined primarily to the activity site viewshed or noiseshed (approximately one-half mile in any direction, or approximately 500 acres). Because all of these identified non-oil and gas activities would be transitory and seasonal, the likelihood of recreationists encountering them in any given location in the 22.6-million-acre planning area is relatively small. However, depending on the activity, there may be some increased likelihood of an encounter with recreationists because of the propensity of recreation activities to concentrate on major rivers. The impacts would be limited to the time in which the recreationists and the other impacting activity are near each other. Because recreationists commonly move through the NPR-A, rather than linger more than a day or two in a single location, the impact would be temporary.

4.3.16.2 Oil and Gas Exploration and Development Activities

Ice roads, Ice pads, Airstrips, and Snow trails

Ice roads, pads, airstrips and snow trails are temporary in nature and traversed during the winter months. Ice roads provide seasonal routes for heavy equipment supplies and movement of personnel to remote staging areas or well locations. Ice airstrips are used to transport crews and supplies to and from sites. Snow trails provide seasonal routes for use by low-ground pressure vehicles and used for moving equipment, supplies, personnel accommodations, and drill rigs capable of disassembly to components small enough for transport on such vehicles. Under Alternative A, the estimated total seasonal acres impacted by ice roads, ice pads, airstrips, and snow trails is 325,508 acres or 108,503 miles. Activities in the winter would be far less visible because of the limited daylight hours. Due to the remoteness and climate of the Reserve, and typical type and frequency of recreation use taking place in the winter, there would be minimal, if any, effect from these activities.

Seismic, Exploration and Delineation wells

Under Alternative A, seismic-survey work could continue throughout the area. There could be up to 11 seismic surveys, 5 exploration-focused and 6 production-focused, for a total estimated short-term impact of 538,052 acres or 56,637 miles (see Table 4-11 on page 69) for surveying and camp train use under Alternative A. The surveys use low-ground-pressure vehicles to minimize potential impacts to the tundra. The typical survey lasts about 100 days. Seismic camps, which generally consist of six camp strings of five ski-mounted trailers, are typically moved every few days to once a week. On-shore seismic surveys on the North Slope are only collected in the winter. The activity would be temporary and disturbance lasts only while the survey or camp train is passing through.

Exploration and delineation wells are typically drilled in the winter in the Reserve. Exploration drilling that has taken place since 1999 involved no more than two drill rigs active simultaneously in the Reserve in any given season. The estimated number of drill rigs per year under Alternative A for exploration and delineation is three oil rigs and four gas rigs. While a rig could be used for multiple wells, each rig could only be used at one site at a time. Typically, drill rigs are removed from the Reserve at the end of the winter drilling season. Drilled wells are either plugged or capped for reentry at a later date. Capped wells have a pipe which would likely be less than 6 feet tall and surrounded by a 6-foot square short fence. The pipe could be a long-term impact, but would be almost unnoticeable from several hundred feet away. Approximately 1,176 acres would have short-term impacts from exploration and delineation wells under Alternative A. Recreation resources could be minimally impacted from the moving camps and associated noise from generators, aircraft, and human presence.

Activities in the winter would be far less visible because of the limited daylight hours. Due to the remoteness and climate of the Reserve and typical type and frequency of recreation use taking place in the winter, there would be minimal, if any, effect on recreation opportunities from these activities. However, the presence of oil and gas winter activity could be beneficial to recreationists in the case of an emergency as a means of communication and/or medical help.

Gravel Pads, Roads, and Airstrips

As part of production activities, an airstrip, roads, camp facilities, and a storage yard could be needed. A borrow site from which to acquire gravel for pads, roads, and an airstrip may be a part of each production operation, but depending on the availability of gravel and the proximity of production operations, some borrow sites may provide gravel for multiple production operations. The only visible disturbance associated with gravel sites from borrow pits would generally only be stockpiled materials. While these sites could be large in size or footprint (about 37 acres each), very little material would remain as stockpile at any one time. Gravel mine sites from aboveground bedrock locations may produce scenic impacts if material is removed from rock outcrops within the planning area. Airstrips would usually be located near a central processing facility for transporting supplies and personnel to the field site.

While the intensity of impacts would be greatest during actual construction and development of the roads and pads, human presence, and associated activity, all could have impacts on recreation resources during the life of the activity. Because production could occur for 10–50 years beyond the development phase, impacts would be long-term. Impacts would be greatest within 1 mile of a road, airstrip, or gravel site, and 2 miles of a pad. The estimated disturbance for the actual footprint of in-field gravel roads, airstrips, and production pads and gravel pits in Alternative A is 7,829 acres. The estimated long-term disturbance for central processing facilities, booster pump stations, compressor stations, and staging bases in Alternative A is 660 acres. The greatest impacts to recreation would be within 2 miles of one of these sites. At this time, it is not known what the layout of this infrastructure would be. Assuming all roads, pads, pits, and airstrips do not overlap with other infrastructure, using a 1-mile impact zone for roads, airstrips, and gravel pits, and a 2-mile impact zone for pads and associated facilities, the approximate total number of acres impacting recreation is 2,283,110 acres. While this may seem like a substantial amount of acreage, the relative proportion of the gravel roads, airstrips, and pads to the Reserve size is minimal. Once built, they would be used year-round. Due to the climate of the Reserve, recreationists would be more likely to see the roads in the summer than winter. However, since this infrastructure would be a part of production activities, they would most likely be off limits to the public. Displacement of recreationists from these areas could adversely affect recreationists' experiences and desired beneficial outcome from use of the public lands. However, the degree of the effect would depend on the actual location of the infrastructure; generally infrastructure distant from routes of travel by recreationists would have little to no effect on recreationists.

The discovery and development of commercial fields is likely to occur gradually across the NPR-A. During production, there would be a production pad, which could potentially support dozens of wells and contain a large central processing facility for an oil field or a combined central processing facility and gas compressor facility for a gas field.

The central processing facility would typically include living quarters and offices, maintenance shops, storage tanks for fuel and water, power generators, waste-treatment units, a communications center, communication towers, aircraft towers, and compressors for gas and water reinjection. They would be constructed as transportable modules that would be supported above the ground on pilings to accommodate ground settling or frost heaving. Communication towers could be as high as 200 feet and well lit.

Recreation resources would be affected by possible displacement, if the activity were to take place at a site previously used for recreation. The actual effects would depend greatly on where development fields were located. The oil and gas facilities, equipment, noise, night lighting, and human activity could alter the recreation setting to an industrial setting, which would interfere with recreationists' goals, and influence their opportunities, activities, experiences, and benefits.

Pipelines

The production operation would include feeder lines, regional pipelines, booster pump (oil) or additional compression stations (gas), a high-pressure gas trunk line, a gas conditioning facility and an oil-sale and/or gas-sale pipeline to transport the resource to market. The actual locations of new pipelines in the NPR-A would depend on the location and sequence of commercial-sized discoveries. Aboveground pipelines for oil would be the preferred method, while gas pipelines would be underground.

Oil pipelines would create a minor visual impact to recreationists who happen to see them, for the length of time that they are in view. While gas pipelines would not be visible, vegetation over the gas pipelines would indicate their location. The dirt work involved with underground pipelines could leave a change in the vegetation (see section 4.3.5, "Vegetation") that would benefit recreationists by creating an easier walking area. Pipelines and associated human activity could alter the recreation setting to an industrial setting, which would interfere with recreationists' goals, and influence their opportunities, activities, experiences and benefits.

Once built, a pipeline would have a long-term impact on the area. Due to the climate of the Reserve and typical recreation activity, a pipeline would be more likely to be seen by a recreationist in the summer months than the winter months.

The estimated long-term disturbance for gathering or feeder lines, gas pipelines and oil pipelines in Alternative A is 1,413 acres and 8,118 acres short term. Short-term impacts would be minimal, temporary, and confined to the immediate area (i.e., within approximately one-half mile in any direction). Assuming a 1-mile impact zone on either side of pipelines, the total long-term impacts to recreation resources from oil and gas pipelines would be approximately 2,022,400 acres.

4.3.16.3 Effectiveness of Stipulations and Required Operating Procedures

Although the lease stipulations and required operating procedures of Alternative A do not specifically address recreation resources, many of the stipulations and required operating procedures of Alternative A would serve to protect recreation resources including Required Operating Procedures A-1 through A-7, A-9, B-1, B-2, C-4, ,E-6, E-7, E-8, and F-1, and Lease Stipulations D-1, E-2, E-3, K-1, and K-2. In addition, over 9 million acres in southwestern NPR-A and Teshekpuk Lake would remain unavailable indefinitely for leasing and development, and, nearly 2 million additional acres are deferred until 2014 or 2018, further protecting recreation resources in the Reserve. Table 2–3 in Volume 1, has a description of the lease stipulations and required operating procedures. These lease stipulations and required operating procedures help protect recreation resources by protecting the natural environment and the resources that recreationists may be interested in such as fish, mammals, birds, vegetation, and water.

4.3.16.4 Conclusion

The impacts from activities not associated with oil and gas on recreation resources would be minimal, seasonal, confined to the immediate area, and present only during the activity for Alternative A. About 538,052 acres or 56,637 miles is expected to be impacted in the short term by seismic activities, 325,508 acres or 108,503 miles of seasonal impacts by the construction of ice roads or airstrips, and snow trails, and 1,176 acres of short-term impacts by exploration and delineation wells as described in the oil and gas scenarios above. However, due to the remoteness and climate of the Reserve, and typical type and frequency of recreation use taking place in the winter, there would be minimal, if any, effect on recreation opportunity from these activities.

The approximate total number of acres impacting recreation resources from gravel pads, roads, and airstrips is 2,116,990 acres. Long-term acres impacted by drilling production, service wells, and pipelines are approximately 2,188,524 acres (9,954 acres short term). These activities could displace recreationists, and thus, adversely affect their experiences and desired beneficial outcome from use of the public lands. However, the degree of the effect would depend on the actual location of the activities and their relationship to recreation opportunities. Pipelines, production activities, and associated human activity could alter the recreation setting to an industrial setting, which would interfere with recreationists' goals, and influence their opportunities, activities, experiences, and benefits.

The impacts on recreation resources would be similar for all alternatives. The biggest difference between the alternatives in relation to recreation resources is the total amount of activity that would take place under each alternative. The short-term acres impacting recreation resources are approximately 881,343 acres, seasonal 325,508 acres, and long-term 4,305,514 acres. Approximately 8.3 million acres would continue to be classified as special areas, further protecting wilderness characteristics in the Reserve. The southern portion of the NPR-A, which has traditionally had the most special recreation permit authorizations per year would not be available for leasing under Alternative A. Also, Alternative A would have the least amount of acres used to conduct seismic surveys.

As the climate gets warmer in NPR-A (Scenarios Network for Alaska Planning 2010), the timing of recreation activities could change. Summer recreation activities could take place for a longer time period and winter activities for a shorter timeframe. Warmer and longer summers could increase the demand for recreational use of the area. Climate change could have an effect on the caribou migration patterns, which would in turn change the location of guided special recreation permit activity taking place. According to the Scenarios Network for Alaska Planning fire map, there would be an increase in fires in the southern portion of NPR-A. The fires could displace special recreation permit permittees.

4.3.17 Wild and Scenic Rivers

Under Alternative A, no rivers in the NPR-A are found to be suitable and recommended for inclusion in the National Wild and Scenic Rivers System. During scoping for this IAP, 12 streams in the planning area were found to meet the minimum requirements for inclusion in the National Wild and Scenic Rivers System, and to lack up-to-date evaluation of their suitability for such designation. The 12 streams, all in the southern and southwestern NPR-A and not covered by the existing Northeast and Northwest NPR-A plans, are the Nigu, Etivluk, Ipnavik, Kuna, Kiligwa, Nuka, Utukok, Awuna, upper Colville, and Kokolik rivers and Driftwood and Carbon creeks. Each of these streams has outstandingly remarkable values, which were identified during scoping by the public and the planning team as described in section 3.4.7.3 (Volume 1, Chapter 3). The outstandingly remarkable values are paleontological resources, recreation, wildlife habitat and wildlife viewing, scenery, cultural resources, and subsistence. Wild and Scenic Rivers should remain free flowing and unpolluted. Under Alternative A, there would be 0 miles of river corridor that would be suitable and recommended in the National Wild and Scenic River System (Table 4-20).

4.3.17.1 Activities Not Associated With Oil and Gas Exploration and Development

Free flow and Water Quality: The 12 eligible rivers would remain free flowing and free of pollution from impacts resulting from non-oil and gas activities under Alternative A, because non-oil and gas activities are not sufficient to cause noticeable impacts.

Outstandingly Remarkable Values: There are no impacts to outstandingly remarkable values identified for the 12 eligible rivers from non-oil and gas activities. Paleontological resources would continue to be studied and there is some chance that unauthorized removal of paleontological resources might occur at a similar level to the current situation. Studies impact a few square meters of surface, and resource theft, while known to occur, is uncommon, and law enforcement efforts in this area are thought to provide deterrence. Wildlife resources along the rivers might be disturbed to a very minor extent by recreational visitors and by aircraft. Recreational activity will likely continue at current levels. Recreational activities along the eligible rivers would not be noticeably impacted by other non-oil and gas activities in the area. Subsistence resources and access would not be impacted by non-oil and gas activities along the eligible streams. Scenery in the area would not be changed by non-oil and gas activities.

Table 4-20. Impacted eligible river miles

Eligible stream	Available for leasing					Recommended for Wild and Scenic River designation				
	Alt. A	Alt. B-1	Alt. B-2	Alt C.	Alt. D	Alt. A	Alt. B-1	Alt. B-2	Alt C.	Alt. D
Upper Colville	0	0	0	0	174	0	174	0	174	0
Utukok	0	40	40	157	222	0	222	0	222	0
Kiligwa	0	0	0	0	51	0	51	0	51	0
Nigu	0	0	0	0	40	0	40	0	0	0
Etivuluk	0	0	0	0	81	0	81	0	0	0
Nuka	0	0	0	0	55	0	55	0	0	0
Kuna	0	0	0	0	63	0	63	0	0	0
Ipnavik	0	0	0	0	83	0	83	0	0	0
Awuna	0	87	87	203	203	0	203	0	0	0
Kokolik	0	19	19	19	73	0	73	0	0	0
Driftwood Cr.	0	0	0	0	36	0	36	0	0	0
Carbon Cr.	0	0	0	54	54	0	54	0	0	0
Totals	**0**	**146**	**146**	**433**	**1,135**	**0**	**1,135**	**0**	**447**	**0**

4.3.17.2 Oil and Gas Exploration and Development Activities

Under Alternative A, all 12 eligible rivers are within the unplanned portion of the NPR-A and no oil and gas leasing and development would occur there. Consequently, there would be no impacts from oil and gas exploration and development activities within NPR-A on free flow, water quality, or the outstandingly remarkable values of these rivers.

4.3.17.3 Effectiveness of Stipulations and Required Operating Procedures

Required Operating Procedures A-2 through A-7 reduce risks to water quality impairment through procedures for handling potential pollutants, preventing spills, and responding to spills. Setbacks in Stipulation K-1 should be effective in reducing potential pollution and visual impacts to eligible streams. The Colville River Special Area Management Plan also provides additional protection to river areas, particularly the lower Awuna, the north-flowing tributaries to the Colville, and the upper Colville.

4.3.17.4 Conclusion

Under Alternative A, in which none of the lands through which the 12 eligible streams flow would be subject to oil and gas leasing, neither non-oil and gas activities nor oil and gas activities within NPR-A would diminish free flow and water quality, nor impact the outstandingly remarkable values in a manner that might preclude Wild and Scenic River designation of some or all of these rivers. There could be some limited impacts to river values of eligible rivers within the planning area as direct or indirect impacts of this alternative where uses do not require federal authorization or are not water resources projects.

Climate change might impact the vegetation and soils along the eligible streams, most noticeably by the intrusion of taller shrubs and thawing permafrost. This would impact the accessibility and scientific values of cultural sites by hiding them, and change the scenic quality of the areas viewable from the stream by limiting vistas. It is possible that melting permafrost could increase sedimentation and turbidity in these streams, reducing water quality.

4.3.18 Wilderness Characteristics

Current wilderness characteristics were described in Chapter 3. Chapter 4 will discuss the impacts to wilderness characteristics based on scenarios discussed in section 4.2. For the purpose of this analysis, short-term impacts are those that the impact is mitigated or removed in 5 or fewer years. Long-term impacts are any impacts that affect wilderness characteristics for longer than 5 years. Seasonal impacts are those that are present for a single work season either winter or summer. The impacts that are being analyzed are based on the scenarios discussed in section 4.2. When characterizing impacts to wilderness characteristics in the NPR-A it is common to calculate impacts in terms of impact areas, usually the direct area of surface disturbance plus a 1- or 2-mile zone around the disturbance depending upon the nature of the disturbance. One and two-mile impact areas are calculated from information found in Table 4-14 of section 4.2.

Wilderness characteristics consist of size, naturalness, and outstanding opportunities for solitude or primitive and unconfined recreation. They may also include supplemental values. For all of the alternatives size is a characteristic that would not be impacted. In relation to the acreage of the entire NPR-A none of the alternatives would reduce any wilderness descriptions (section 3.3.18 in Volume 1) to less than 5,000 acres. One and 2-mile impact areas are calculated from information found in Table 4-14 of section 4.2.

Wilderness Characteristics Alternative A – Alternative A would continue to allow leases to be offered for oil and gas exploration and development on 57 percent of NPR-A subsurface lands. Another 1.57 million acres would remain deferred from oil and gas leasing until 2014; and 425,000 acres deferred until 2018. There are 8.3 million acres that would remain as special areas (Teshekpuk Lake Special Area, Colville River Special Area, Utukok River Uplands Special Area, and Kasegaluk Lagoon Special Area). Alternative A does not recommend any rivers for wild and scenic river status.

4.3.18.1 Activities Not Associated with Oil and Gas Exploration and Development

Under Alternative A, the characteristics of wilderness (i.e., naturalness, outstanding opportunities for solitude or primitive and unconfined recreation, and supplemental values) could be affected on a seasonal basis as they are now by on-the-ground activities such as archeological collection efforts, field camps, survey work, scientific research, recreation activities, film permits, hazardous and solid material removal, and overland moves. At the current level of activity, the seasonal impact of these activities to wilderness characteristics would be minimal, due to the size of the planning area, the temporary nature of the activities, and the limited human intrusion. The area would remain roadless and allow for outstanding opportunities for solitude or primitive and unconfined recreation. The supplementary values of wilderness characteristics (ecological, geological, or other features of scientific educational, scenic, or historical value) would remain similar in nature. Wildlife viewing opportunities would for the most part remain very good, as would opportunities for scientific study. However, aircraft use associated with research could result in temporary impacts to wildlife viewing. These impacts would be minimal and short term. Overall, the impacts to wilderness characteristics from non-oil and gas activities under Alternative A are insignificant for the planning area.

4.3.18.2 Oil and Gas Exploration and Development Activities

Seismic Surveys

Under Alternative A, seismic-survey work could continue throughout the area with as many as three to four operations each winter season. There could be up to 11 seismic surveys, 5 exploration-focused and 6 production-focused, for a total estimated short-term disturbance of 538,100 acres (see Table 4-11 on page 69) for surveying and camp train use under Alternative A. The surveys use low-ground-pressure vehicles to minimize potential impacts to the tundra. The typical survey lasts about 100 days. Seismic camps, which generally consist of six camp strings of five ski-mounted trailers, are typically moved every few days to once a week. Wilderness characteristics of naturalness, outstanding opportunities for solitude or primitive and unconfined recreation, and scenic values could be minimally impacted from the moving camps and associated noise from generators, aircraft, and human presence. The impact would be minimal, temporary, and confined to the immediate area (i.e., within approximately 0.5 mile in any direction).

A longer lasting impact could be to vegetation resulting from seismic survey operations (see section 4.3.5), which could impact naturalness and scenic values. The color contrast would be minimal from ground view and almost nonexistent from more than a few hundred feet away. After 8 to 9 years, the evidence of use would be minimal. Seismic operations by their nature do not follow the same routes every year and the number of miles of survey line run can vary greatly from year to year.

Ice Roads, Pads, Airstrips and Snow Trails

Ice roads, ice pads, airstrips, and snow trails are temporary in nature and traversed during the winter months. Ice roads provide seasonal routes for heavy equipment supplies, and movement of personnel to remote staging areas or well locations. Ice airstrips are used to transport crews and supplies to and from sites. Snow trails provide seasonal routes for use by low-ground pressure vehicles and used for moving equipment, supplies, personnel accommodations, and drill rigs capable of disassembly to components small enough for transport on such vehicles. The estimated total seasonal acres disturbed by ice roads, ice pads, airstrips and snow trails is 325,508 acres. The wilderness characteristics of naturalness, solitude, and primitive and unconfined recreation could be minimally impacted from the associated noise from generators, aircraft, and human presence. The impact would be minimal, temporary, and confined to the immediate area (i.e., within approximately 0.5 mile in any direction).

Exploration and Delineation Wells

Exploration drilling since 1999 involved no more than two drill rigs active simultaneously in the Reserve in any given season. The estimated number of drill rigs per year under Alternative A for exploration/delineation is three oil rigs and four gas rigs. While a rig could be used for multiple wells each rig could only be used at one site at a time. Typically, drill rigs are removed from the Reserve at the end of the winter drilling season. Drilled wells are either plugged or capped for reentry at a later date.

The wilderness characteristics of naturalness and outstanding opportunities for solitude or primitive and unconfined recreation could be minimally impacted from the associated noise from generators, vehicles, and human presence. Approximately 1,176 acres would have short-term disturbance from exploration and delineation wells under Alternative A. The impact would be minimal, temporary, and confined to the immediate area (i.e., within approximately 0.5 mile in any direction). For well sites that are capped, a wellhead would remain on site. Due to the remoteness and expansiveness of the Reserve, a capped wellhead would not impact wilderness characteristics.

Gravel Pads, Roads, and Airstrips

As part of production activities an airstrip, camp facilities, and a storage yard could be needed. A borrow site from which to acquire gravel for pads, roads, and an airstrip may be a part of each production operation, but depending on the availability of gravel and the proximity of production operations, some borrow sites may provide gravel for multiple production operations. The only visible disturbance associated with gravel sites from borrow pits would generally only be stockpiled materials. While these sites could be large in size or footprint (about 37 acres each), very little material would remain as stockpile at any one time. Gravel mine sites from aboveground bedrock locations may produce visual impacts if material is removed from rock outcrops within the planning area. Airstrips would usually be located near a central processing facility for transport of supplies and personnel to the field site.

While the intensity of impacts would be greatest during actual construction and development of these facilities, remaining structures (i.e., roads, pads, airstrips), human presence and associated activity, and noise all would have impacts on wilderness characteristics during the life of the activity. Because production could occur for 10 to 50 years beyond the development phase, impacts to wilderness characteristics of naturalness, and outstanding opportunities for solitude or primitive and unconfined recreation, and scenic supplemental values would be long term. Impacts would be greatest within 1 mile of a road, airstrip, or gravel site; and 2 miles of a pad. The estimated usage for in-field gravel roads, airstrips, gravel pads, and gravel pits in Alternative A is 7,829 acres. The estimated long-term disturbance for central processing facilities, booster pump stations, compressor stations and staging bases in Alternative A is 660 acres. The greatest impacts to wilderness characteristics would be within 2 miles of one of these sites. At this time it is not known what the layout of this infrastructure would be. Assuming all roads, pads, pits, and airstrips do not overlap with other infrastructure; a 1-mile impact zone for roads, airstrips, and gravel pits; and a 2-mile impact zone for pads and associated facilities; the approximate total number of acres impacting wilderness characteristics is 2,116,990 acres. The actual effects would depend greatly on where development fields were located. The BLM can require removal of gravel roads/pads/airstrips after the life of the activity, or could decide to allow them to remain forever, which would have a permanent impact on wilderness character. If these activities impair wilderness characteristics in the future the areas would be excluded from the inventory of lands with wilderness characteristics.

The discovery and development of commercial fields is likely to occur gradually across the NPR-A. During production, there would be a production pad, which could potentially support dozens of wells and contain a large central processing facility for an oil field or a combined central processing facility/gas compressor facility for a gas field.

The central processing facility would typically include living quarters and offices, maintenance shops, storage tanks for fuel and water, power generators, waste-treatment units, a communications center, communication towers, aircraft towers, and compressors for gas and water reinjection. They would be constructed as transportable modules, which would be supported above the ground on pilings to accommodate ground settling or frost heaving. Communication towers could be as high as 200 feet and well lit.

Pipelines

The production operation would include feeder lines, regional pipelines, booster pump (oil) or additional compression stations (gas), a high pressure gas trunk line, a gas conditioning facility, and an a oil-sale and/or gas-sale pipeline to transport the resource to market. The actual locations of new pipelines in the NPR-A would depend on the location and sequence of commercial-sized discoveries. Aboveground pipelines for oil would be the preferred method while gas pipelines would be underground. Because production could occur for 10 to 50 years beyond the development phase, impacts to wilderness characteristics of naturalness, outstanding opportunities for solitude or primitive and unconfined recreation, and scenic supplemental values would be long term. The estimated long-term disturbance for gathering/feeder lines, gas pipelines, and oil pipelines in Alternative A is 1,413 acres and 8,118 acres in the short term. Short-term impacts would be minimal, temporary, and confined to the immediate area (i.e., within approximately 0.5 mile in any direction). Assuming a 1-mile impact zone on either side of a pipeline the total long-term impacts to wilderness characteristics from oil and gas pipelines would be approximately 2,022,400 acres. If these activities impair wilderness characteristics in the future the areas would be excluded from the inventory of lands with wilderness characteristics.

4.3.18.3 Effectiveness of Stipulations and Required Operating Procedures

Although the lease stipulations and required operating procedures of Alternative A do not specifically address wilderness characteristics and the BLM is not considering recommending designation of wilderness in the planning area, many of the standards required for development of Alternative A would serve to protect wilderness characteristics including required operating procedures A-1 through A-7, B-2, C-2, C-3, E-1, E-4, E-13, and F-1,and lease stipulations D-1, D-2, G-1. In addition, over 9 million acres in southwestern NPR-A and Teshekpuk Lake would remain unavailable indefinitely for leasing and development and, nearly 2 million additional acres are deferred until 2014 or 2018, further protecting wilderness characteristics in the Reserve. Table 2–3 in Volume 1, Chapter 2 has a description of the stipulations and required operating procedures/best management practices. These lease stipulations and required operating procedures help protect wilderness characteristics by protecting the natural environment and resources such as fish, mammals, birds, vegetation, and water.

4.3.18.4 Conclusion

The impacts from activities not associated with oil and gas on wilderness characteristics would be minimal and short term, present only during the activity for Alternative A. About 538,100 acres would be expected to be impacted by seismic activities, 355,000 acres by the construction of ice roads, ice pads, airstrips and snow trails and 1,248 acres by exploration and delineation wells as described in the oil and gas scenarios above. The impact would be minimal, temporary, and confined to the immediate area. However, there may be evidence of seismic activity for 8 to 9 years.

The approximate total number of acres impacting wilderness characteristics from gravel pads, roads, and airstrips is 2,116,990 acres. Long-term acres impacted by drilling production, service wells, and pipelines are approximately 2,188,524 acres (9,954 acres in the short term). If activities impair wilderness characteristics in the future, the areas would be excluded from the inventory of lands with wilderness characteristics.

Disturbance from long-term, seasonal and short-term actions could potentially impact approximately slightly more than 4 million of the NPR-A's nearly 23 million acres in a manner that could impair wilderness characteristics. Of the remaining 19 million acres in the NPR-A, 8.3 million acres of lands with wilderness characteristics would be protected by special designation or by being deferred from leasing and development. The balance of the lands with wilderness characteristics, 10.6 million acres, would not have measures taken to specifically protect lands with wilderness characteristics, but are not anticipated to be subject to actions that would cause wilderness characteristics to be lost.

The impacts on wilderness characteristics would be similar for all alternatives. The biggest difference between the alternatives in relation to wilderness characteristics is the total amount of activity that would take place under each alternative. Alternative A would have the least amount of acres used to conduct seismic surveys. The supplemental values that an area may contain of ecological, geological, or other features of scientific, education, scenic, or historical value may be affected if the climate continues to warm in the NPR-A (Scenarios Network for Alaska Planning 2010). See climate sections within the Physical Environment and Biological Resources sections for more information.

4.3.19 Visual Resources

Section 3.4.9 in Volume 1 discusses the visual resource inventory classes. Sections 4.4.19 (Volume 2), 4.5.19, 4.6.19, and 4.7.19 (Volume 3) present the visual resource management classes for each alternative. Visual resource management classes are based on the management decisions made through planning efforts. The BLM uses the "Visual Resource Management" system to help protect scenic values by reducing visual contrasts in the landscape. Each class has objectives for obtaining a particular level of management as shown below.

Class I Objectives:

- Provide the most protection and are generally designated Wilderness, Wilderness Study Areas, Outstanding Natural Areas or Primitive Areas, visually sensitive Areas of Critical Environmental Concern, or wild sections of Wild and Scenic Rivers
- Preserve the existing character of the landscape
- Provide for natural ecological change
- Provide for limited management activity
- Level of change to the landscape should be very low; and must not attract attention

Class II Objectives:

- Retain the existing character of the landscape
- Level of change to the landscape should be low
- Management activities may be seen but should not attract attention of the observer
- Changes should repeat the basic elements found in predominate natural features of the landscape (form, line, color, and texture)

Class III Objectives:

- Partially retain the existing character of the landscape
- Level of change to the landscape can be moderate
- Management activities may attract attention, but should not dominate the view of the casual observer
- Change should repeat the basic elements found in the natural landscape (form, line, color and texture)

Class IV Objectives:

- Provide for activities that require major modification of the landscape
- Level of change to the landscape can be high
- Management activities may dominate the view and be the major focus of attention
- Minimize impacts through location and design by repeating form, line, color and texture

Table 4-21 provides a comparative analysis between the percent of the acres of inventory class versus the percent of the acres of Visual Resource Management classes. To facilitate impact analysis, Visual Resource Management classes represent the allowable levels of impacts described above and the inventory classes represent the general existing condition of the landscape, or baseline as described in section 3.4.9, Volume 1.

Table 4-21. Visual resource inventory and management classes by alternative

	Visual resource inventory class					
	Class I	**Class II**	**Class III**	**Class IV**	**None**	**TOTAL**
	0%	21%	42%	37%	%	100%
Alternatives	**Visual resource management class by alternative**					
Alternative A						
VRM I	1%					
VRM II		0%				
VRM III			22%			
VRM IV				17%		
None					61%	
Total						100%
Alternative B-1						
VRM I	3%					
VRM II		16%				
VRM III			31%			
VRM IV				50%		
None					0%	
Total						100%
Alternative B-2						
VRM I	0%					
VRM II		37%				
VRM III			26%			
VRM IV				37%		
None					0%	
Total						100%
Alternative C						
VRM I	1%					
VRM II		0%				
VRM III			33%			
VRM IV				65%		
None					0%	
Total						100%
Alternative D						
VRM I	0%					
VRM II		0%				
VRM III			0%			
VRM IV				100%		
None					0%	
Total						100%

Methods of Analysis

For the purpose of this analysis, short-term visual impacts are those that are mitigated or removed in 5 or fewer years. Long-term visual impacts are any impacts that last longer than 5 years. Seasonal impacts are those that are present for a single work season either winter or summer. The impacts that are being analyzed are the scenarios discussed in section 4.2. The impacts that are being analyzed are based on the scenarios discussed in section 4.2. When characterizing impacts to visual resources in the NPR-A it is common to calculate impacts in terms of impact areas, usually the direct area of surface disturbance plus a 1- or 2-mile zone around the disturbance depending upon the nature of the disturbance. One and two-mile impact areas are calculated from information found in Table 4-14 of section 4.2.

Visual resources refer to the visible features, and objects, natural, man-made, moving and stationary, which comprise the character of the landscape observed from a given location or key observation point. Any action that provides or allows for contrast with the existing elements of the landscape has the potential to impact the visual resource. To evaluate the impact of the proposed alternatives on visual resources the quantitative measure of the percent of acres of visual inventory classes that are prescribed to specific Visual Resource Management class objectives is used to disclose the anticipated loss or protection of visual quality in the existing environment. Impacts to visual resources are those that contrast with the existing environment when viewed by the casual observer. However, due to the remoteness and size of the Reserve and the nature of the climate, casual observers are not a frequent occurrence. Contrast can be with landscape characteristics of form, line, texture, or color. Any new oil and gas production activities would be subject to NEPA analysis, which would include a Visual Resource Management contrast rating and visual simulation. Those activities proposed that would not initially meet Visual Resource Management objectives for the area would be mitigated to the extent needed to meet the objectives.

Under Alternative A, the lands along the Colville River within the Northwest NPR-A only, are designated Visual Resource Management Class I (1 percent of NPR-A) (Map 2-5). The objective of this class is to preserve or retain the existing character of the landscape. Identified estuarine areas and lands along the other 21 rivers eligible for designation as Wild and Scenic Rivers in the Northwest NPR-A plan are designated Visual Resource Management Class III (22 percent of NPR-A). These Visual Resource Management classes apply to all lands within 3 miles of the banks of all identified waterbodies. This class would generally allow for moderate levels of change to occur to the visual characteristics of the landscape. The remainder of the Northwest NPR-A planning area is designated Visual Resource Management Class IV (17 percent of NPR-A). The levels of change allowed for this class can be high. The rest of the NPR-A does not currently have a Visual Resource Management class designated (61 percent of NPR-A).

4.3.19.1 Activities Not Associated with Oil and Gas Exploration and Development

Under Alternative A, impacts to visual resources could result from on-the-ground management activities, such as archaeological collection efforts, field camps, survey work, overland movements, recreation activities, film permits, hazardous and solid material removal, and remediation activities. Temporary structures such as tents, vehicles such as Rolligons, aircraft, human presence, and associated activities would have some minimal seasonal impacts on visual resources or scenic quality, by creating a weak contrast to form, line, color, and texture of a primarily horizontal natural landscape. In Visual Resource Management terms the definition of weak is: The element contrast can be seen, but does not attract attention (H-8431-1). The colors of structures and equipment would contrast with the white color of the snow-covered landscape and the various hues of greens and browns of summer vegetation. The form and line would contrast with the uneven patchy landscape. The smooth texture of the structures would contrast with the irregular texture of vegetation. These activities would need to occur within the Foreground-Middleground Zone of the viewshed in order to attract the attention of the casual observer.

Activities not associated with oil and gas exploration and development would be seasonal, and therefore the casual observer would be minimally impacted. The size or scale of a particular project would be minimal. Most of the activities would take place during the summer when there is a prevalence of daylight, allowing activities to be seen from a farther distance than winter activities. Lights from equipment used during winter activities, such as overland moves, would be the only visual sight due to limited daylight hours. The lights on the equipment would only be visible while the equipment is passing through. The likelihood of a casual observer being near is practically nil in the winter. However, winter overland moves could leave long lasting impacts to vegetation (see section 4.3.5). The contrast would be minimal from ground view and almost nonexistent from more than a few hundred feet away. After 8 to 9 years, the evidence of use would be minimal. The overall impacts from activities not associated with oil and gas exploration and development would be minimal, temporary, and confined to the immediate area (i.e., within approximately 0.5 mile in any direction).

4.3.19.2 Oil and Gas Exploration and Development Activities

Seismic Surveys

Under Alternative A, seismic-survey work could continue throughout the area with as many as three to four operations each winter season. There could be up to 11 seismic surveys, 5 exploration-focused and 6 production-focused, under Alternative A for a total of estimated 538,100 acres impacted by surveying and camp train use. The surveys use low-ground-pressure vehicles to minimize potential impacts to the tundra. The typical survey lasts about 100 days. Seismic camps, which generally consist of six camp strings of five ski-mounted trailers, are typically moved every few days to once a week.

On-shore seismic surveys on the North Slope are only collected in the winter, therefore the colors of structures and equipment would have a weak contrast with the white color of the snow-covered landscape. Activities in the winter would be far less visible due to the limited daylight hours, although lights on equipment would be visible when the equipment is passing through an area. Due to the remoteness and climate of the Reserve the casual observer would not likely be present to be affected visually by the seismic activity. Local subsistence users could be traveling on the tundra and observe the seismic activity (see section 4.3.13). Visual resources could be minimally impacted from the moving camps, aircraft, and human presence. The seismic operations would have a moderate contrast on the landscape character element of line. In Visual Resource Management terms the definition of moderate is: “The element contrast begins to attract attention and begins to dominate the characteristic landscape” (H-8431-1). The seismic equipment would represent a bold line on a large mass of continuous white.

A longer lasting visual impact could be to vegetation resulting from seismic survey operations (see section 4.3.13). Because trails visually modify existing vegetation, they would not produce much contrast to line, form, or texture. The color contrast would be minimal from ground view and almost nonexistent from more than a few hundred feet away. After 8 to 9 years the evidence of use would be minimal. Seismic operations by their nature do not follow the same routes every year and the number of miles of survey line run can vary greatly from year to year.

Ice Roads, Pads, Airstrips and Snow Trails

Ice roads, pads, airstrips, and snow trails are temporary in nature and traversed during the winter months. Ice roads provide seasonal routes for heavy equipment, supplies, and personnel accommodations moving to remote staging areas or well locations. Ice airstrips are used to transport crews and supplies to and from sites. Snow trails provide seasonal routes for use by low-ground-pressure vehicles and are used for moving equipment, supplies, personnel accommodations, and drill rigs capable of disassembly to components small enough for transport on such vehicles.

Activities in the winter would be far less visible due to the limited daylight hours, although lights on equipment would be visible when the equipment is passing through an area. Due to the remoteness and climate of the Reserve, the casual observer would not likely be present to be affected visually by this activity. Local subsistence users could be traveling on the tundra and observe the activity (see section 4.3.13). Visual resources could be minimally impacted from the moving camps, aircraft, and human presence. The estimated total seasonal acres impacted by ice roads, ice pads, airstrips, and snow trails are 325,508 acres.

Exploration and Delineation Wells

Exploration and delineation wells are typically drilled in the winter in the Reserve. Exploration drilling that has taken place since 1999 involved no more than two drill rigs active simultaneously in the Reserve in any given season. The estimated number of drill rigs per year under Alternative A for exploration/delineation is three oil rigs and four gas rigs. While a rig could be used for multiple wells, each rig could only be used at one site at a time. Typically, drill rigs are removed from the Reserve at the end of the winter drilling season. Drilled wells are either plugged or capped for reentry at a later date. Capped wells have a pipe that would likely be less than 6 feet tall and surrounded by a short fence 6 feet square. The pipe could be a long-term impact, but would be almost unnoticeable from several hundred feet away. Approximately 1,176 acres would have short-term impacts from exploration and delineation wells under Alternative A.

Activities in the winter would be far less visible due to the limited daylight hours, although lights on equipment would be visible when the equipment is passing through an area. Due to the remoteness and climate of the Reserve, the casual observer would not likely be present to be affected visually by this activity. Local subsistence users could be traveling on the tundra and observe the activity (see section 4.3.13). Visual resources could be minimally impacted from the moving camps, aircraft, and human presence.

Gravel Pads, Roads, and Airstrips

As part of production activities an airstrip, roads, camp facilities and a storage yard could be needed. A borrow site from which to acquire gravel for pads, roads, and an airstrip may be a part of each production operation, but depending on the availability of gravel and the proximity of production operations, some borrow sites may provide gravel for multiple production operations. The only visible disturbance associated with gravel sites from borrow pits would generally only be stockpiled materials. While these sites could be large in size or footprint (about 37 acres each), very little material would remain as stockpile at any one time. Gravel mine sites in the NPR-A from aboveground bedrock locations may produce visual impacts if material is removed from rock outcrops. This mining activity would change the form of the natural landscape and may be visible from the Foreground-Middleground Zone. Airstrips would usually be located near a central processing facility for transport of supplies and personnel to the field site.

While the intensity of impacts would be greatest during actual construction and development of the roads and pads, human presence and associated activity could also have impacts on visual resources during the life of the activity. The landscape of the Reserve is homogeneous, without little visual variety and contrast. Therefore, building a road would be expected to cause a weak amount of contrast to the form of the land. It would minimally impact the landscape character element of line through introduction of the location and road, both of which would be visible linear features. Exposing the soil would cause a weak impact to the color in the landscape. The texture of the exposed soil would be smoother than the existing landscape, thus creating a weak contrast. When an application is received for a road, a visual contrast rating would be completed to determine the actual contrast, along with a visual simulation, and mitigation measures would be determined to maintain the appropriate Visual Resource Management class.

Because production could occur for 10 to 50 years beyond the development phase, impacts would be long term. These impacts would be greatest within 1 mile of a site. The estimated disturbance for the actual footprint of in-field gravel roads, airstrips, and production pads and gravel pits in Alternative A is 7,829 acres. The estimated long-term use for central processing facilities, booster pump stations, compressor stations and staging bases in Alternative A is 660 acres. The greatest impacts would be within 2 miles of one of these sites. At this time it is not known what the layout of this infrastructure would be. Assuming all roads, pads, pits, and airstrips do not overlap with other infrastructure; using a 1-mile impact zone for roads, airstrips, and gravel pits; a 2-mile impact zone for pads and associated facilities; about 2,283,110 acres would be impacted (see Table 4-14 on page 76).

The relative proportion of the gravel roads, airstrips, and pads to the Reserve size is minimal. Once built, they would be used year-round. Due to the climate of the Reserve, the casual observer would be more likely to be in the Reserve to see the roads in the summer than winter. The impact associated with the graveled pads and roads would be moderate, long term, and confined to the 1- and 2-mile impact zones.

The discovery and development of commercial fields is likely to occur gradually across the NPR-A. During production, there would be a production pad, which could potentially support dozens of wells and contain a large central processing facility for an oil field or a combined central processing facility/gas compressor facility for a gas field.

The central processing facility would typically include living quarters and offices, maintenance shops, storage tanks for fuel and water, power generators, waste-treatment units, a communications center, communication towers, aircraft towers, and compressors for gas and water reinjection. They would be constructed as transportable modules, which would be supported above the ground on pilings to accommodate ground settling or frost heaving. Communication towers could be as high as 200 feet and well lit.

The blocky, rectangular form of the structures would contrast strongly with the existing landscape. In Visual Resource Management terms the definition of strongly is: The element contrast demands attention, will not be overlooked, and is dominant in the landscape (H-8431-1). They would introduce distinct vertical lines, which would strongly contrast with the existing horizontal landscape. The smooth texture of the structures would strongly contrast with the coarser texture of the surrounding vegetation. Potential impacts would include artificial light and associated sky glow from winter drilling. This lighting would degrade scenic quality by introducing intrusive, artificial lighting into an otherwise unlit natural landscape that would be visible from a distance of approximately 17 miles (based on a 200-foot tower, calculated mathematically).

Visual resources would be moderately impacted long term, and confined to the area of view. The actual effects would depend greatly on where development fields were located.

Pipelines

The production operation would include feeder lines, regional pipelines, booster pump (oil) or additional compression stations (gas), a high-pressure gas trunk line, a gas conditioning facility and an oil-sale and/or gas-sale pipeline to transport the resource to market. The actual locations of new pipelines in the NPR-A would depend on the location and sequence of commercial-sized discoveries. Aboveground pipelines for oil would be the preferred method while gas pipelines would be underground.

Building a pipeline would cause a strong amount of contrast to the form of the land. It would moderately impact the landscape character element of line through introduction of the location and pipeline, both of which would be visible linear features. Exposing the soil would cause a weak impact to the color in the landscape. The texture of the exposed soil would be smoother than the existing landscape, thus creating a weak contrast. Once the pipeline is built, it would have a moderate contrast with the form of the land. The NPR-A has many lakes of various sizes and shapes. A pipeline crossing the lakes would create a moderate contrast. The color contrast would depend on the color of the pipeline. Assuming the pipeline is grayish silver, there could be a moderate contrast with the colors in the landscape. The texture of the pipeline would be smooth compared to the existing landscape.

Once built, a pipeline would have a long-term impact on the area, being more visible in the summer months than the winter months. The estimated long-term disturbance for gathering/feeder lines, gas pipelines, and oil pipelines in Alternative A is 1,413 acres, and 8,118 acres in the short term. Assuming a 1-mile impact zone around oil pipelines (which are above ground), the total long-term impacts to visual resources from oil and gas pipelines would be approximately 2,022,400 acres. Visual resources would be moderately impacted long term, but confined to the immediate area. The actual effects would depend greatly on where development fields were located.

4.3.19.3 Effectiveness of Stipulations and Required Operating Procedures

Although the lease stipulations and required operating procedures of Alternative A do not specifically address visual resources, many of the stipulations and required operating procedures of Alternative A would serve to protect visual resources including required operating procedures A-1through A-7, C-2, C-3, E-1, E-5, and E-15, and lease stipulations D-1, D-2, G-1, by regulating overland moves, seismic work, exploratory drilling, facility design, construction and siting of facilities, water use, minimize impacts to solid and hazardous waste, minimize contaminants, and the protection of stream banks. In addition, over 9 million acres in southwestern NPR-A and Teshekpuk Lake would remain unavailable indefinitely for leasing and development, and nearly 2 million additional acres are deferred until 2014 and 2018, further protecting visual resources in the Reserve. Table 2–3 in Chapter 2, Volume 1, has a description of the stipulations and required operating procedures. These lease stipulations and required operating procedures help protect visual resources by protecting the natural environment and resources such as fish, mammals, birds, vegetation, and water.

4.3.19.4 Conclusion

The impacts from activities not associated with oil and gas on visual resources would be minimal, confined to the immediate area, and for the most part concurrent with activities. About 538,100 acres would be expected to be impacted by seismic activities, which for the most part would be minimal, temporary, and confined to the immediate area. There may be evidence of seismic activity for 8 to 9 years. Approximately 325,508 acres would be impacted by the construction of ice roads/airstrips and snow trails, and 1,176 acres by exploration and delineation wells as described in the oil and gas scenarios above. The impacts from the construction of ice roads/ airstrips and snow trails, and drilling of exploration wells and delineation wells are expected to be minimal, temporary, and confined to the immediate area.

The approximate total number of acres impacting visual resources from gravel pads, roads, and airstrips is 2,116,990 acres. Long-term acres impacted by drilling production, service wells and pipelines are 2,188,524 acres, 9,954 acres in the short term. The impact to visual resources from gravel pads, roads and drilling production, service wells, and pipelines are expected to be moderate, long term, and confined to the 1- and 2-mile zones. When an application is received for these kinds of activities a visual simulation would be conducted for the NEPA analysis for each project, which would determine the actual impact expected. A visual contrast rating would also be completed and mitigation measures would be determined to maintain the appropriate Visual Resource Management class.

Climate change could affect visual resource values by altering the current conditions of color, vegetation, adjacent scenery, and the presence of water. Shifts in public sensitivity could occur as well. The biggest difference between the alternatives is the total amount of activity that affects visual resources and the associated acreage, because all the alternatives would have similar types of impacts. Disturbance from long-term, seasonal and short-term actions could potentially impact approximately slightly more than 4 million of the NPR-A's nearly 23 million acres in a manner that could impact visual resources. Approximately 8.3 million acres would continue to comprise Special Areas, further protecting visual resources in the Reserve. Alternative A would have the least amount of acres used to conduct seismic surveys. The acres impacted with this alternative are more than Alternatives B-1 and B-2, but less than Alternatives C and D. The Visual Resource Management classes determined in Alternative A would create more lands in Class I, less Class II, less Class III, and less Class IV than the visual resource inventory.

4.3.19.5 Potential Mitigation Measure (New Required Operating Procedure)

Objective: Manage permitted activities to meet Visual Resource Management class objectives described below.

Class I: Natural ecological changes and very limited management activity are allowed. The level of change to the characteristic landscape should be very low and must not attract attention.

Class II: The level of change to the characteristic landscape should be low. Management activities may be seen, but should not dominate the view of the casual observer. Any changes should repeat the basic elements of form, line, color, and texture found in the predominant natural features of the characteristic landscape.

Class III: The level of change to the characteristic landscape should be moderate. Management activities may attract attention, but should not dominate the view of the casual observer. Changes should repeat the basic elements found in the predominant natural features of the characteristic landscape.

Class IV: The level of change to the characteristic landscape can be high. These management activities may dominate the view and be the major focus of viewer attention. However, every attempt should be made to minimize impacts through location and design by repeating form, line, color, and texture.

Requirement/Standard: At the time of application for construction of permanent facilities, the lessee/permittee shall, after consultation with the authorized officer, submit a plan to best minimize visual impacts, consistent with the Visual Resource Management class for the lands on which facilities would be located. A photo simulation of the proposed facilities may be a necessary element of the plan.

Potential Benefits and Residual/Unavoidable Impacts: Requiring that visual impacts be considered early in the design of a development will reduce the potential for impacts to visual resources. The authorized officer will be able to provide guidance on best practices, such as the color, dimensions, and shape of facilities, and evaluation of surrounding scenic values meriting protection. Some impacts to visual resources will be unavoidable from developments of the size necessary for oil and gas development. The protection that this measure would provide may also benefit recreation and wilderness characteristics. Development and adoption of measures in a visual resource protection plan could add expense to activities involving permanent facilities, though many measures could be adopted with little or no expense.

4.3.20 Economy

This section presents general market indicators related to broad outcomes of alternatives. It is assumed that oil and gas lease bids will be reduced by the expected cost of compliance, so the federal government (and State of Alaska, through revenue sharing) ultimately incurs the cost, while residents of the areas expected to be affected share the nonmarket benefit. If the lease tracts become unprofitable because of environmental protections, companies will not bid on new tracts or pursue exploration or development of existing leases. Again, the cost and benefit is borne by the federal government and State of Alaska as companies pursue development opportunities elsewhere. No estimates have been made in this IAP/EIS of the cost of regulations (including the protective measures associated with each of the alternatives) or the nonmarket value ascribed to biologic or other resources, though other sections present qualitative analysis of impacts to those resources by the alternatives.

4.3.20.1 Activities Not Associated with Oil and Gas Exploration and Development

Recreational river rafting will occur in the planning area, primarily on the Colville River. The BLM estimates (see Table 4-1 on page 3) that 6 to12 trips, each with 10 to 12 persons, would take place each year. Employment generated by this activity would result from air taxi service and guide service. Neither of these services originates within the planning area. Air taxi services used for Colville River access originate in Bettles, Kotzebue, Fairbanks, and Coldfoot. Guides originate in Bettles, but may also originate from other locales in Alaska outside the North Slope, or may originate outside Alaska entirely (Delaney 2007). Permitted commercial guided activities will result in fees to the federal government. Operators or guides pay 3 percent of gross revenues for special recreation permits, with a minimum $100 per permit. The special recreation permits generate a minimum of $600 for the federal treasury each year.

Other activities, such as research or surveys, various ground activities, and aircraft use not related to petroleum are shown in Table 4-1 on page 3 and additional activities related to offshore petroleum are discussed at the end of section 4.2.1.1. As with recreational activities, the air taxi and other services generally originate outside of the NPR-A, and result in little economic benefit to the North Slope. North Slope Borough residents may be employed in some of these activities, as will other Alaskans and nonresidents. No fee is collected for non-recreational activities listed. To the extent that these are funded by federal agencies, it is possible that the level of activity for research-related activities will be reduced in the coming decade from the current average of 20 non-BLM project permits per year, or that the scope of projects will be restricted, depending on budget constraints.

4.3.20.2 Oil and Gas Exploration and Development Activities

The U.S. Geological Survey economic analysis of undiscovered hydrocarbons in this geologic province was performed by establishing a statistical model of expected pool size variation in the province (Houseknecht 2010), defining generalized engineering parameters by pool size, and estimating financial costs of production for each engineering model at specified petroleum prices (Attanasi 2011). Economically recoverable volumes include all pools where revenues would exceed costs using available technology, development practices, and environmental protections similar to that in the Central Arctic, factoring in a reasonable return on investment. There are several uncertainties involved in the analysis. Specific pools are not identified and may require unanticipated engineering solutions to produce. Expenses may be higher or lower at the time of development, as the result of inflation, changing technology, improved practices, changed environmental requirements, or other factors. The price of the product may be substantially different from those used in the analysis. These uncertainties are addressed using appropriate probability distributions in stochastic simulations, which result in a range of statistically defined outcomes. Such theoretical outcomes have been applied to the analysis of the BLM's management decisions to provide a comparison of alternatives. This should not be construed as a prediction of future activity, although it presents a useful basis of analysis when everything else is held constant. This analysis is intended to compare results of the BLM's management alternatives, and not for other purposes.

According to the scenarios presented in section 4.2, oil production will start no sooner than 2017 in all alternatives, beginning at the existing Mooses Tooth and Bear Tooth units as a step out from the existing Alpine and Alpine satellite developments. Additional oil production in the scenario may occur at Umiat on currently leased tracts beginning after 2021 for all alternatives. In Alternative A, exploration, development, and production of presently undiscovered oil and gas are assumed on existing leased and unleased tracts beginning after 2031. Peak oil production in this alternative is calculated at 74,000 barrels of oil per day in 2033 to 2040. This is inadequate to maintain Trans-Alaska Pipeline System operation without production from other sources, but would help maintain production above an economic threshold of 270,000 barrels per day for over 4 years at peak production, based on Energy Information Administration 2035 projections of Alaska production (USDOE/EIA 2012) and the recent throughput decline rate of 6 percent. Peak gas production is 1.54 billion cubic feet per day in 2033 to 2044. Soon after 2033, up to 11 oil central processing facilities and 30 gas compressor facilities will be in operation. The fields will continue to produce and probably incur other development beyond the end of peak production, though at some point, the cost of production will exceed the revenue derived. At that time, the equipment will be removed and the facilities deconstructed, resulting in additional short-term employment. The development progression for undiscovered oil and gas is similar for all alternatives, though the volume and rate of oil and gas production differs.

Revenues

There are several revenue streams resulting from oil leasing and production, further described in section 3.4.11 in Volume 1. Bonus bids are monies received for the right to lease parcels offered and vary directly with the likelihood of resource value and profitability, but have been calculated at the minimum rate to lease all of the available but unleased acreage. A royalty is assessed based upon the federal royalty rate of 16.67 percent of wellhead value for the high oil potential area, and 12.5 percent for the remainder of the NPR-A, so 12.5 percent was used for the undiscovered volumes. By law (42 U.S.C. § 6506a), the State and federal governments share the NPR-A bonuses, rents, and royalties equally. The State must then share a portion of this amount with local government, in this case North Slope Borough, in accordance with State law. State corporate income tax at 4 percent was used for this analysis. Federal corporate income tax was standardized at 35 percent for any lessee. The State production tax calculation uses Alaska's Clear and Equitable Share methodology for 2011, which has a base rate of 25 percent of production tax value (wellhead price minus operating costs per barrel of oil equivalent). There is also a minimum rate of

0.4 percent of wellhead price and rate increases when the production tax value exceeds $30, plus additional aspects that have been included in the computations. State property taxes are assessed at the rate of 2 percent on the value of production and transportation hardware, although the State retains 0.2 percent, while1.8 percent goes to the North Slope Borough for properties in the Borough. Simplifications were necessary, and follow those used by the U.S. Geological Survey in its economic assessment of the Reserve (Attanasi 2011).

In most cases, this analysis relies on simplified computations or assumed rates, because it is not possible to determine the results of individual transactions in theoretical scenarios. These estimates are largely based on the assumptions in the U.S. Geological Survey analysis (Attanasi 2011) used as the basis for section 4.2.2, with additional information and simplification required to address practical considerations in presenting the alternatives. Calculation of most governmental revenues required preparation of a simplified cash flow using a Microsoft Excel workbook along the lines developed by the Minerals Management Service (Craig 2001) and previously used for the Northeast NPR-A Supplemental IAP/EIS, adapted for the changes to Alaska's production tax computation and the assumptions noted above. Rather than preparing cash flows by mineral occurrence, this analysis used averages to determine distance from existing infrastructure and size of processing facilities, for example. As a result, the economic outcomes are similar to those reported by the U.S. Geological Survey, but do not mirror those results. Because this was not an investment analysis, but the comparison of resource values between alternatives that occur during the same timeframes, it was not considered necessary to include inflation to calculate future revenue streams or discount the cash flow or revenue streams to present value.

Combined production from discovered oil and gas in the Greater Mooses Tooth and Bear Tooth units and at Umiat is estimated to total 270 million barrels of oil and 905 billion cubic feet of natural gas. As modeled, this will result in revenues of about $11.7 billion to all levels of government, for an annual average of $425 million, if both operations were to occur at the same time. Average annual revenues consist of $162 million for royalties (to be split between the State and federal treasuries), federal corporate income taxes of $88 million, state corporate taxes of $11 million, production tax of $144 million, petroleum property tax to North Slope Borough of $18 million, and petroleum property tax to the state of $2 million.

Bonus bids are estimated to be $130 million or an annual average of $4.3 million over the next 30 years. Exploration, development, and production activities for the undiscovered resources are estimated to generate over $40 billion in revenue to various levels of government, for an annual average of $1.4 billion over the 27 years of production envisioned in the development scenario. Property tax revenue to the North Slope Borough is estimated to average $120 million and State property taxes are expected to average $13 million per year. Annual royalty payments split equally by the State of Alaska and the federal government is expected to average $519 million for undiscovered resources. State income taxes will average approximately $51 million from undiscovered resources. Federal income tax is expected to be $428 million. In addition, $309 million in State production taxes could be generated. As modeled, corporate profits would total about $30.9 billion, or less than 76 percent of the governmental revenues from the activities. The government and lessee would share about $36 of the $180 price for each barrel of oil equivalent, with the remaining $144 representing the 2010 cost of production for these remote mineral occurrences. All estimates are based upon 2010 constant dollar costs and average prices of $180 per barrel for oil and $8.67 per thousand cubic feet for gas. These were the basis of the estimate of economic reserves in section 4.2.1.

Table 4-22 presents the outcomes for development and production of both the currently leased tracts and the undiscovered resources. These total $4.6 billion to the North Slope Borough, $25.6 billion to the State of Alaska, and $25.2 billion to the Federal Treasury. This would result in nearly $55.4 billion over the life of all projects and an average revenue of $2 billion if all occurrences are developed simultaneously.

Table 4-22. Alternative A revenues (in millions of 2010 dollars)

	North Slope Borough		State of Alaska		Federal	
	Total	**Average annual***	**Total**	**Average annual***	**Total**	**Average annual***
Bonus bids**			65	2.2	65	2.2
Royalty			10,080	340.5	9,412	340.5
Property tax	3,797	138.0	422	15.0		
Corporate income tax			1,722	62.0	14,467	516.0
Production tax			12,769	453.0		
Totals	**3,797**	**138.0**	**24,390**	**872.7**	**23,944**	**858.7**

* If all projects occur simultaneously.
** Over next 30 years.

Employment (New or Continued)

The number of workers needed to construct or operate the infrastructure would be determined by the scale of the infrastructure, the level of effort exploring and developing a field, and, to a lesser extent, the amount of oil or gas produced. Once the infrastructure was in place, the number of workers needed to operate it would generally not depend on the amount of product flowing through it.

For the purposes of this analysis it is assumed that about 10 to 20 years of exploration, proving, permitting, facility construction, and development drilling precede initial production. It is also assumed that development of multiple occurrences can occur simultaneously, without constraint of equipment or personnel, and with adequate access to pipelines and other infrastructure to send products to market. There is considerable economic benefit in bringing production online gradually to ensure long-term maximum utilization of pipeline capacity, and that is assumed by designating a period of level maximum annual production before production decline for the NPR-A as a whole.

The following employment estimates were used to derive models on which to calculate employment estimates. During exploration, the BLM estimates 40 to 60 personnel for each survey crew. Exploration and development drilling will employ crews of up to 30 to 60 workers per rig. An Alpine-sized processing facility requires about 400 to 600 workers to build. Road and pipeline construction requires about 40 to 60 employees for each. The Alpine central processing facility operation requires 360 to 480 workers on two shifts per month (Rothwell 2007). Absent an estimate of employment for gas production on the North

Slope, it was assumed that a gas processing facility would employ a similar number as an oil processing facility. A smaller model was necessary for developing the undiscovered resources in the NPR-A, based on the average daily production from the small occurrences modeled. Production is about 20 percent or less of the Alpine facility rate, and the estimates for central processing facility operation are 20 percent of the lower number of employees for Alpine. It is possible that this underestimates the personnel requirements, and employment will actually be larger. In all instances, lower ends of personnel counts were used so as to not overestimate employment.

The BLM is counting each worker each year on each unit of activity as a job, so annual averages provide a useful interpretation of long-term employment, but that requires an assumption that all projects occur over the same 25- to 30-year period. If scenario development occurs over 50 to 60 years, the annual average will be half of what is shown. Survey, exploration drilling, and construction personnel may be employed for less than three to six months on a single project. As a result, about half of the jobs presented in Table 4-23 can be expected to occur in the exploration and development stages and do not represent a year of employment or ongoing employment in the NPR-A. However, it does represent the continuation of employment that is also carried out in other parts of the North Slope and Alaska. For example, someone may work part of the year at Alpine, so working part of the year or the next year in the NPR-A is included as a continued job.

Table 4-23. Potential employment under Alternative A

	Alternative total	Annual average
Total for all places of residence	532,105	13,725
Direct	222,160	5,657
Indirect & Induced	309,945	8,068
North Slope Borough total	20,759	577
Direct	11,328	314
Indirect & Induced	9,431	263
Other Alaska total	417,380	10,726
Direct	155,293	3,929
Indirect & Induced	262,087	6,797
Outside Alaska total	94,329	2,422
Direct	55,541	1,414
Indirect & Induced	38,788	1,008

Direct oil and gas employment is employment in drilling and production, petroleum engineering and similar work, and does not include support activities, such as transportation and supply. For this analysis, direct employment includes construction activities for production site facilities and other direct infrastructure. It is anticipated that total North Slope Borough resident employment would capture approximately 8 percent of direct exploration and development jobs and about 3 percent of the production jobs (USDOI BLM 2005). It is possible that development in closer proximity to villages and the ongoing efforts of training and mentoring will result in a greater level of direct employment for all aspects of oil and gas activity among North Slope residents, which might result in higher income levels and lower unemployment for area villages. While the higher participation might be a natural outcome or useful mitigation measure, it has not been included in these estimates.

Indirect employment includes work by suppliers and contractors. These may be working at the same site as direct employees, or may be located thousands of miles away. Induced employment includes expenditures by employees and other payees of the lessees. As an example, property tax and secondary royalty revenue funds support employment by the North Slope Borough, including education and construction activities for the Borough and its agencies. The BLM estimated total indirect and induced employment to be as high as 300 percent of the exploration direct employment and about 130 percent at development and production stages. North Slope Borough indirect and induced employment was estimated to be about 170 percent of North Slope Borough direct employment during exploration, 68 percent during development, and 86 percent during production (USDOI BLM 2005).

During the last decade, 25 to 29 percent of Alaska's oil industry workers have been non-residents of this state. These workers commute from outside Alaska, and do not generate measurable induced employment in Alaska (Fried and Windisch-Cole 2003). The economic impact of non-resident employment on the United States is negligible for all alternatives (Fried and Windisch-Cole 2003).

Other Effects of Oil and Gas Development

Under Alternative A, if health problems arise due to air or water pollution or other causes as described in section 3.4.12 “Public Health” (Volume 1), there would be increased economic costs both for individuals and government associated with concerns such as health care, social services, and law enforcement. To the extent that mitigation measures to protect public health or other values are adopted, additional lessee costs would reduce private and some government revenues listed above.

Development under Alternative A could also contribute to some increase in the cost of engaging in subsistence activities. Costs would include fuel, supplies, equipment, and additional time, particularly as travel is increased to avoid production facilities or related activities. To the extent that local employment is increased, the additional costs could be more easily absorbed.

Alternative A is not likely to affect the cost of fuel or supplies brought to the villages. The chief executive officer of Kuukpik Corporation stated he could not see changes in economies resulting from the operation of ice roads (Chinn 2007). Unless there is a gravel road connecting Nuiqsut or other North Slope villages to the state's road network, which is not anticipated as part of this IAP/EIS, it is unlikely that costs would change significantly.

With the possible exception of services related to health, social services, and law enforcement noted above, public infrastructure costs, including schools and local airports, are not likely to be affected by development under Alternative A. North Slope oil fields are largely self-sufficient for emergency services and health and social services. For example, oil facilities typically include emergency medical technicians, clinical facilities, and emergency transportation. Air traffic from oil and gas development may be directed toward oil field airstrips, not community airports. The continuation of oil and gas revenues, including new petroleum properties subject to North Slope Borough taxation, will continue to support existing infrastructure and services.

4.3.20.3 Conclusion

Oil and gas exploration and development would benefit the local, State, and national economy by increasing revenues and employment. Over $52 billion would flow to all levels of government. There would be $24 billion for the federal government, $24.4 billion for the State of Alaska, and $3.7 billion for the North Slope Borough. The number of jobs created by exploration, development, and production would total 532,105 direct and indirect over the life of all projects. An average of 577 North Slope Borough resident jobs would be added or continued if discovered and undiscovered resources were developed simultaneously. Increased costs to harvest subsistence resources could affect the economic well-being of North Slope Borough residents, primarily through increased costs to reach subsistence resources.

4.3.21 Public Health

4.3.21.1 Activities Not Associated with Oil and Gas Exploration and Development

The activities not associated with oil and gas exploration and development are described in section 4.2.1.1 and include aircraft use, river trips and other recreational uses, site cleanup and remediation activities, overland moves, archeological surveys, and site work.

Under Alternative A, these activities should not have a significant impact on public health. Localized impacts on subsistence are likely, primarily as a result of displacement of animals as a result of aircraft noise. In addition, the presence of camps, whether or not they cause displacement of animals, may result in avoidance of the immediate area by hunters in an effort to minimize conflict. These impacts are described in section 4.3.13. The effect of such activities is likely to be localized and temporary.

Alterations in the success of subsistence activities can have an impact on health, primarily by way of nutritional outcomes and risk of injury. The mechanisms of these effects are described in section 4.3.21.2. For any individual person affected, the impact of an unsuccessful hunt or an accident or injury on the land could be severe. However, given the transient and highly localized nature of these activities, it is unlikely that there will be any measurable impact on public health at a population level.

4.3.21.2 Oil and Gas Exploration and Development Activities

The oil and gas exploration activities described in section 4.2.1.2 may lead to alterations in public health and safety via a number of different pathways. These include diet and nutrition, environmental exposures, infectious disease, safety, acculturative stress, economic impacts, and capacity of local health care services. Each of these pathways and the potential impacts of Alternative A on that pathway are described below.

Diet and Nutrition

Health impacts resulting from changes in diet and nutrition are a major concern when oil and gas developments affect populations reliant on subsistence resources. In such situations, dietary changes may result from displacement or contamination of food sources, avoidance or loss of traditional harvesting lands, increased reliance on store-bought foods and changes in the ability to afford the costs associated with hunting and fishing.

The preservation and promotion of a subsistence diet in northern Alaska is of great importance to public health. Research has shown that the consumption of traditional foods is associated with reduced risk of chronic diseases such as diabetes, hypertension, hypercholesterolemia, cardiovascular disease and stroke (Chan et al. 2006, Dewailly et al. 2001, Dewailly et al. 2002, ADHSS 2005, Murphy et al. 1995, Ebbesson et al. 2007, Reynolds et al. 2006, Murphy et al. 1995, Adler et al. 1994, Adler et al. 1996, Ebbesson et al. 1999). In contrast to this, the nutritional value of store-bought food in rural Alaskan villages tends to be low and the cost of buying nutritious foods (such as fruits, vegetables, and whole grains) is often prohibitively expensive (Bersamin and Luick 2006). The result is that when subsistence resources become less accessible and people rely more heavily on store-bought foods to replace traditional sources, the nutritional value of the diet decreases, and the risk of developing problems such as diabetes increases (Murphy et al. 1997, Young et al. 1992, Bjerregaard et al. 2004). Although traditional foods are popular and their health benefits are widely promoted, there has been a slow and generally unhealthy trend away from a subsistence diet and toward store-bought foods. Any exacerbation of this shift away from a subsistence diet is likely to cause an increase in metabolic disorders such as obesity, heart disease, and diabetes.

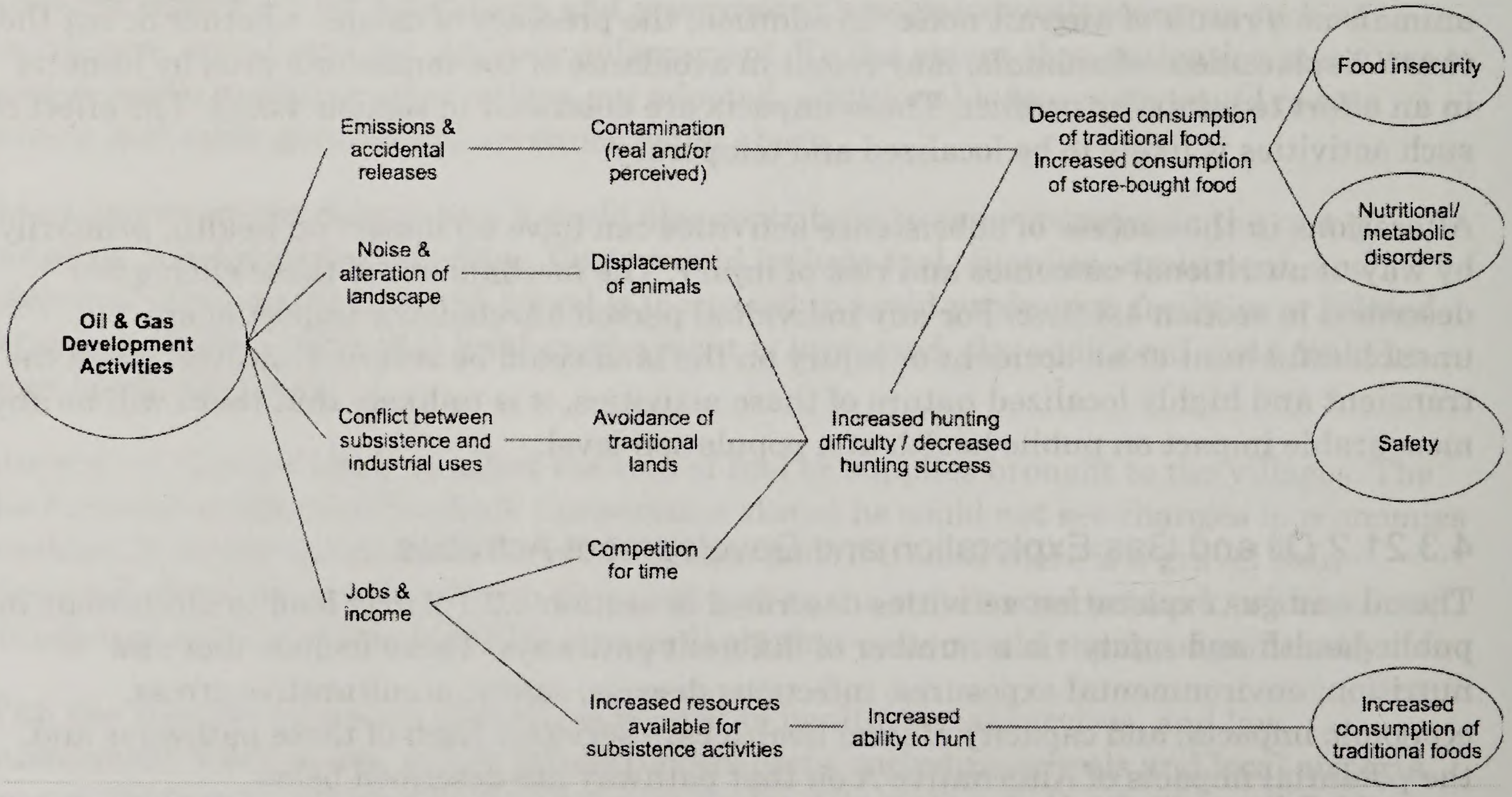
Oil & Gas Development Activities
Emissions & accidental releases
Contamination (real and/or perceived)
Noise & alteration of landscape
Displacement of animals
Conflict between subsistence and industrial uses
Avoidance of traditional lands
Jobs & income
Competition for time
Increased resources available for subsistence activities
Increased ability to hunt
Decreased consumption of traditional food. Increased consumption of store-bought food
Increased hunting difficulty / decreased hunting success
Food insecurity
Nutritional/ metabolic disorders
Safety
Increased consumption of traditional foods

Figure 4—23. Linkages to diet and nutrition from oil and gas development activities

Food insecurity is another concern in the North Slope Borough, as it is in other subsistence-based indigenous populations in the north. Food insecurity refers to a family's inability to secure sufficient healthy food. Studies have found a variety of detrimental health impacts of food insecurity including overweight/obesity, poor psychological functioning among children, poor cardiovascular health outcomes, and lower physical and mental health ratings (Olson 1999, Stuff et al. 2004, Seligman et al. 2010). The high cost of store-bought food, the costs associated with harvesting subsistence resources, and the year-to-year variation in subsistence resource availability is all implicated in high rates of food insecurity in many northern indigenous populations.

As described in section 3.4.12 in Volume 1, reliance on subsistence foods is very high in the North Slope Borough. In the 2010 North Slope Borough census, between 44 and 67 percent of households indicated that they get at least half of their meals from subsistence sources, and virtually all Iñupiat households reported relying on subsistence resources to some extent (Circumpolar Research Associates 2010). As described in Chapter 3, rates of obesity, diabetes, and heart disease–all outcomes associated with dietary changes toward less-healthy foods—have been rising rapidly in the study area over the last several decades. This combination of a high reliance on subsistence foods and metabolic changes in the population means that changes to the availability or quality of subsistence resources are likely to have detrimental impacts on nutritional health outcomes and food insecurity for the local population. A compensating factor is that the wide variety of traditional food sources has provided most communities with the ability to adapt to transient changes in availability of single species. This has historically helped temper the dietary and nutritional impact of year-to-year variability in the success of the hunt.

The likelihood of impacts to subsistence harvests under Alternative A is discussed in section 4.3.13. Nuiqsut, Atqasuk, and Barrow would be the most highly impacted communities, as these villages obtain most of their non-marine traditional food from the affected lands. Wainwright and Anaktuvuk Pass will be affected to a lesser degree, as they depend somewhat on fish and caribou harvested from potentially affected areas within the NPR-A. While all subsistence food sources are important, caribou and fish are the two of most heavily relied-upon resources from the NPR-A. Reductions in the success of these harvests for any of the villages dependent on the planning area would accelerate the transition from subsistence resources to store-bought foods, worsening nutritional outcomes and food insecurity. The protection of calving and insect-relief area for the Western Arctic caribou herd under Alternative A will help minimize this impact.

Nuiqsut hunters, who already avoid large areas of traditional land to the northeast of the village, could experience further limitation in their access to lands to the south and west of the village if intensive oil and gas development occurs there. Avoidance of productive land may reduce harvests and exacerbate dietary and nutritional outcomes independent of any direct impact on the animals themselves.

Production at Umiat has the potential to impact the hunters of Anaktuvuk Pass. The impact of this development on subsistence is described in section 4.3.13 and includes the potential of conflict between Iñupiat subsistence activities and visiting sport hunters.

Environmental Exposures

Activities associated with oil and gas exploration and production can affect human health via changes to environmental conditions. Oil and gas-related activities may affect air quality or water quality, resulting in potential increases in acute or chronic health effects;

the contaminant burden in subsistence food sources, resulting in potential changes in the healthfulness or acceptability of local foods; or noise levels, resulting in potential effects ranging from minor irritation and annoyance to more severe health outcomes (see Figure 4—24). Whether any health effects manifest from exposure to environmental hazards depends on several factors, including the nature of the hazard, the amount and duration of exposure, and the sensitivity of the person who comes in contact with it.

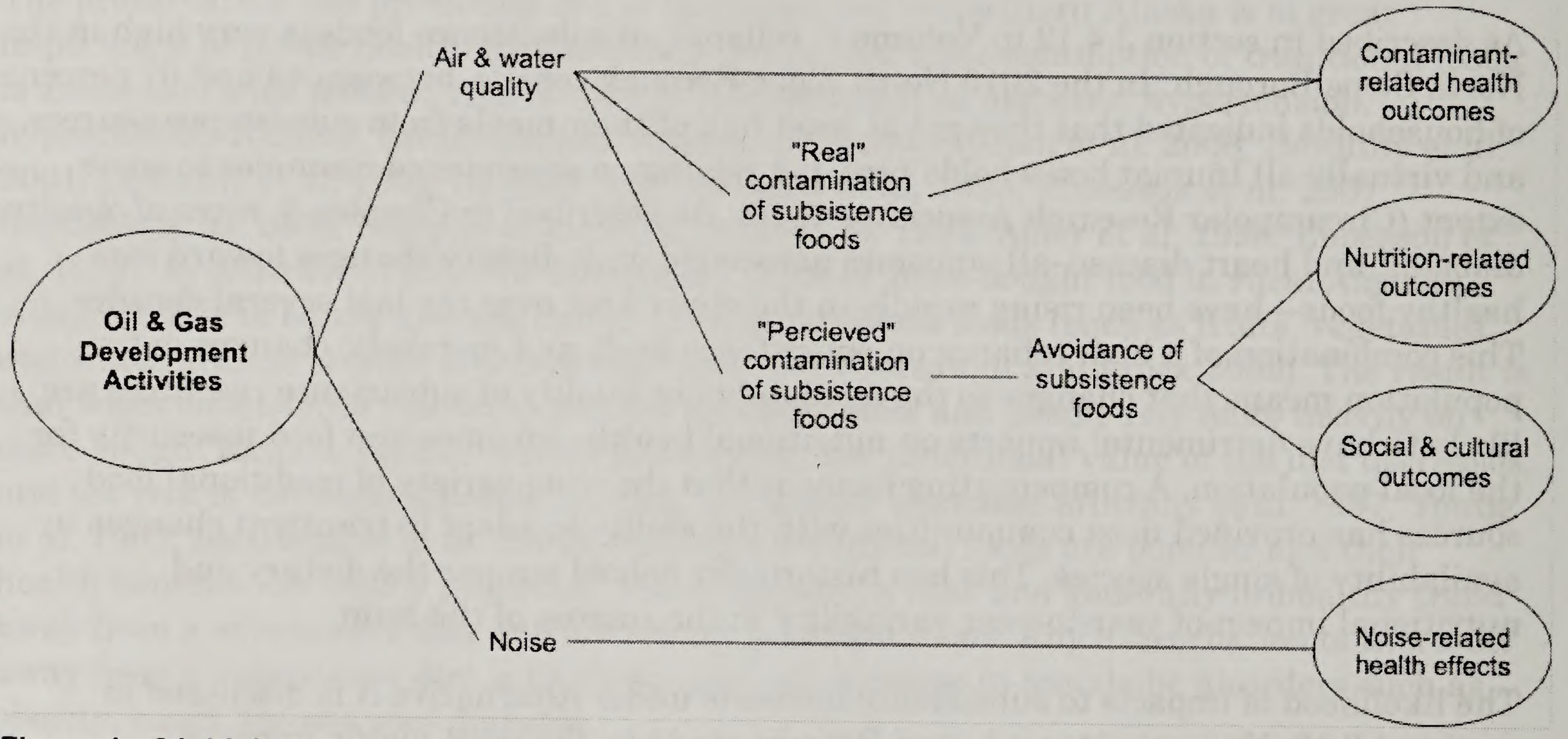
Air & water quality
Contaminant-related health outcomes
"Real" contamination of subsistence foods
Nutrition-related outcomes
Oil & Gas Development Activities
"Percieved" contamination of subsistence foods
Avoidance of subsistence foods
Social & cultural outcomes
Noise
Noise-related health effects

Figure 4—24. Linkages to environmental exposures from oil and gas development activities

Air Quality Effects

As discussed extensively in section 4.3.1, oil and gas development and related activities result in airborne emissions. The primary sources of airborne emissions include construction dust, road dust, vehicle and machinery emissions, flaring and venting of gas, burning of refuse, and emissions from power generation as well as other sources.

The air pollutants emitted by these activities include a number of Environmental Protection Agency (EPA) criteria pollutants such as nitrogen oxides (NO_x), sulfur dioxide (SO_2), particulate matter (PM, including both $PM_{2.5}$ and PM_{10}), carbon dioxide, and ozone. These substances have been linked with a range of health effects, the most notable of which are asthma, chronic bronchitis, decreased pulmonary function, cardiovascular events, increased hospital admissions, and increased mortality (EPA 1999). Table 4-24 summarizes the health effects that have been linked with each of these pollutants.

In addition, other hazardous air pollutants may also be emitted, including benzene, toluene, ethylbenzene, and xylenes. Chronic exposure to hazardous air pollutants has been associated with irritation of the skin, eyes, and lungs; the development of some cancers; neurologic effects; reproductive effects; and gastrointestinal effects (EPA 2000a, 2000b, and 2000c).

Table 4-24. Health effects linked with EPA criteria pollutants

Pollutant	Sources (Not comprehensive)	Health effects
Carbon monoxide (CO)	Motor vehicle exhaust, flaring	Headaches, reduced mental alertness, heart attack, cardiovascular diseases, impaired fetal development, death.
Sulfur dioxide (SO_2)	Coal-fired power plants, petroleum refineries, flaring	Eye irritation, wheezing, chest tightness, shortness of breath, lung damage.
Nitrogen dioxide (NO_2)	Motor vehicles, flaring, other industrial sources that burn fuels.	Susceptibility to respiratory infections, irritation of the lungs and respiratory symptoms (e.g., cough, chest pain, difficulty breathing).
Ozone (O_3)	Vehicle exhaust and certain other fumes. Formed from other air pollutants in the presence of sunlight.	Eye and throat irritation, coughing, respiratory tract problems, asthma, lung damage.
Particulate matter (PM)	Diesel engines, power plants, windblown dust	Eye irritation, asthma, bronchitis, lung damage, cancer, heavy metal poisoning, cardiovascular effects.

Source: Environmental Protection Agency. 2011. Effects of Air Pollutants – Health Effects. Available at: http://www.epa.gov/eogapti1/course422/ap7a.html#table. Accessed Nov. 10, 2011.

Both EPA and the State of Alaska have established legal limits for air pollution based on scientific evidence, known as Ambient Air Quality Standards (NAAQS), to protect public health. However, according to EPA analysis and several independent studies, substantial health effects may accrue at even levels below NAAQS standards (Ostro et al. 2006; U.S. Environmental Protection Agency 2006b). Significantly, the populations most at risk of experiencing health effects at levels under the NAAQS are vulnerable populations, including children, the elderly, and people with chronic illnesses.

Water Quality Effects

Water can also be a source of human exposure to environmental contaminants. As described in section 4.3.4, the activities that could occur under Alternative A have the potential to affect water quality through accidental spills or releases; or as the byproduct of construction, excavation, or human habitation. A wide range of acute and chronic human health effects are possible, depending on the specific substances released and the extent of exposure.

Water quality has the potential to affect health in the NPR-A communities if exposure to harmful substances occurs via drinking water. Currently, the residential water supply typically comprises treated lake water that is either piped or trucked to homes. When people are on the land, water is obtained from lakes, streams, and melted snow and ice.

Contamination of Food Sources

The waste products emitted into environmental media by oil and gas activities have the potential to bioaccumulate within the food chain. Chronic exposure to these substances can increase the risk of cancer and can adversely affect the respiratory, pulmonary, gastrointestinal, renal, or dermatologic systems (Agency for Toxic substances and Disease Registry 2009).

A number of studies have examined the current contaminant load in animals used for subsistence purposes in the North Slope communities. Contaminants examined have included metals such as arsenic, cadmium, lead, total and methyl mercury, and silver; chlorinated hydrocarbons and related compounds; and polycyclic aromatic hydrocarbons, as well as other substances (Moses, 2009; Verbrugge 2004; Becker 2000; Wetzel 2008). Not all of these contaminants are found in or originate from oil and gas development and related activities; contaminants in the Arctic have also been transported from more distant regions by oceanic and atmospheric circulation.

Currently, there appears to be little contamination of traditional foods in the NPR-A (Moses 2009, U.S. Department of Commerce 2008, Wetzel et al. 2008). While elevated levels of contaminants have been found in several species (Becker 2000), the levels found in subsistence foods in the North Slope area appear at present to be generally low, compared with other Arctic areas, and are lower than what would trigger public health concern (North Slope Borough 2006). Environmental contaminants in local foods do not represent a threat to the health of subsistence users at current levels (U.S. Department of Commerce 2008, Wetzel et al. 2008).

Regardless of the actual level of environmental contamination, the perception of exposure to contamination can have an adverse impact on health. Perception of contamination causes stress and anxiety about the safety of subsistence foods and avoidance of subsistence food sources (Canadian Environmental Assessment Agency 2010, Loring et al. 2010), which can, in turn, result in changes in nutrition-related diseases. Despite the current safety of traditional foods in the North Slope Borough, many Iñupiat residents report that they are concerned that oil and gas activities could increase contaminant loads of subsistence foods to a level that would threaten human health (Poppel et al. 2007). Concerns center around accidental oil spills, persistent leaks, and poor waste management practices. At present, in the villages outside Barrow, 44 percent of Iñupiat residents report concern that fish and animals may be unsafe to eat (Poppel et al. 2007). Residents also have distrust of regulatory bodies, believing that contaminant thresholds developed by regulatory bodies do not take into account the large volume of fish and game consumed in the region (USDOI BLM 2005). These concerns, however, do not appear to have yet resulted in persistent changes in consumption patterns or avoidance of traditional foods.

Noise-related Health Effects

Research has found that environmental noise may cause health effects that include annoyance and sleep disturbance (for noise in the range of 40 to 55 decibels (acoustic)), decreased school performance, auditory impairment and ischemic heart disease (for noise in the range of 65 to 70 decibels (acoustic)) (World Health Organization 2009). In general, intermittent, higher frequency, short-duration, intense sounds have greater impacts on health than do continuous low-frequency, long-duration, low-intensity sounds (London Health Commission 2003).

Under Alternative A, environmental conditions are expected to change in a way that could result in changes in air quality, water quality, the healthfulness or acceptability of subsistence food sources, and noise levels.

Air quality changes are most likely to occur at and near the areas of oil and gas development. The proximity of these areas to population centers is discussed in the air quality section of Chapter 3. If these sites are at a distance from most population centers in or near the NPR-A, associated changes in health measurable at the population level (rather than the individual level) are unlikely to be seen, and the overall impact to human health is likely to be low. The individuals most likely to be affected would be those who stay in cabins or other residences that relatively close to development areas. In particular, dust from construction activities or traffic may become an issue. In addition, because of high baseline levels of respiratory disease and other illnesses that may be exacerbated by air quality decreases, ensuring that air quality remains within established standards may not be sufficient to protect the health of all individuals. Flaring is also potentially a concern. In Nuiqsut, where flaring can be seen from the village, some people are already concerned that health is suffering from flaring. The validity of this link is not currently possible to establish; however, the perception of health detriment poses an important risk communication challenge for ongoing development, and may be reproduced in other communities or areas where flaring can be observed.

Water contamination could occur via two routes: through chemical contamination or through biological contamination. Biological contamination (that is, contamination through biological organisms) would not be expected to occur under Alternative A, as long as the work camps and other facilities adhere to best practices for wastewater management as required by Required Operating Procedure A-2. Chemical contamination could occur through accidental discharges into watercourses that supply human water sources, particularly in areas of cabins or transient subsistence uses of the land. However, the likelihood of any such discharge occurring with resultant human exposure is low, given the stipulations and best management practices around waste prevention, handling, disposal, spills, and public safety. If exposure occurred under these circumstances, the exposure would be likely to be short-term and intermittent, and unlikely to lead to significant health effects.

Section 4.3.13 concludes that there is a low likelihood of contamination of subsistence food sources, with the possible exception of contamination through an oil spill. This is supported by current low measurable impacts despite high levels of oil and gas activities on the North Slope in the past. Except in the event of a major spill (discussed in section 4.11.4.21 in Volume 4), there are likely to be only negligible to minor health effects from contamination of food sources as a result of the activities associated with Alternative A. However, even at the current low levels of contaminants, perception of contamination is widespread in the NPR-A communities. Any future oil and gas activity is likely to add to this perception. Although any anticipated change in risk perception will likely be below the threshold required to see measurable changes in health outcomes, ongoing oil and gas exploration activity has the potential to reduce confidence in subsistence resources and subsequent consumption.

Development activities will result in environmental noise being generated. Noise sources will include construction activities, seismic and drilling work, gravel mining, noise from stationary sources such as generators and compressors, truck traffic and other vehicle (land and water) use, and noise from aircraft overflights. Given the location of development, the area where noise interaction is most likely to occur is at cabins and camps. Development-related noise may cause irritation, annoyance, or sleep disturbance among individuals who experience it. Until site-specific development activities are proposed, the extent of this effect is not possible to determine.

Infectious Disease

In-migration of oil and gas workers into remote communities is frequently associated with transmission of infectious disease to the resident population (Goldenberg et al. 2008). Respiratory illnesses, influenza, and sexually transmitted diseases are of particular concern (Figure 4—25). The North Slope region has a high rate of pulmonary disease and could be particularly susceptible to outbreaks of influenza and other viral respiratory infections. In addition, the rate of Human Immunodeficiency Virus (HIV) and syphilis are lower in the North Slope Borough than in the rest of Alaska or U.S. general population. Contact with outsiders increases the risk of these diseases entering and spreading within the resident population of the North Slope.

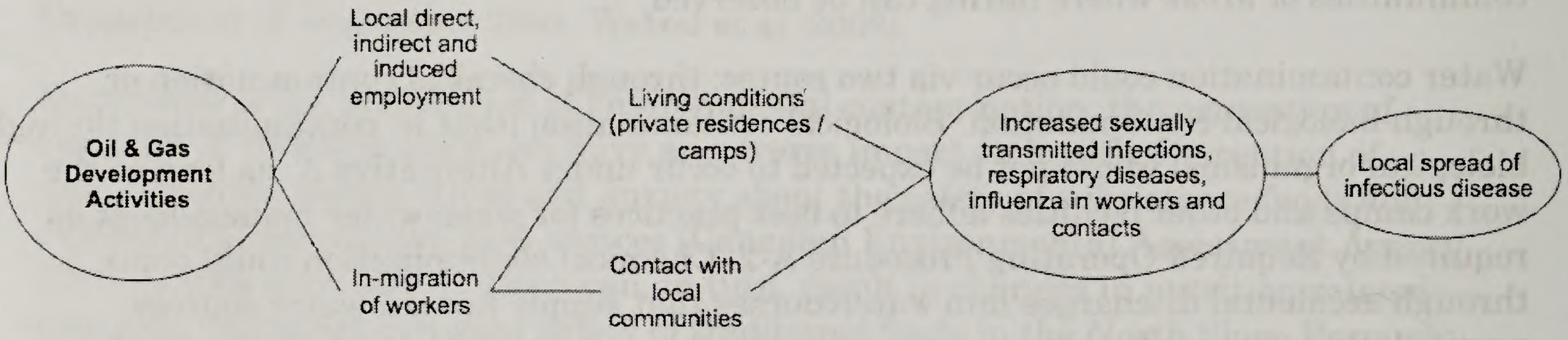
Oil & Gas Development Activities
Local direct, indirect and induced employment
In-migration of workers
Living conditions (private residences / camps)
Contact with local communities
Increased sexually transmitted infections, respiratory diseases, influenza in workers and contacts
Local spread of infectious disease

Figure 4—25. Linkages to infectious disease from oil and gas development activities

To date, low levels of fraternization between outside workers and Iñupiat, due both to the history of enclave development and relatively low participation rate of locals in work camp environments, has been protective against the rise of infectious disease in the North Slope Borough. However, under Alternative A, increased local labor force participation and the presence of outside workers in closer contact with local communities will increase the risk of sexually transmitted diseases and respiratory disease.

Coordination between the North Slope Borough Department of Health and Social Services and the operators of work camps to monitor infectious disease and to develop effective strategies to prevent the transmission of influenza and sexually transmitted infections is lacking.

Safety

Indigenous populations in the Arctic and elsewhere have very high rates of accidents and trauma (Alaska Native Tribal Health Consortium 2008; Day et al. 2006). This is particularly true in Alaska as is reflected in the high rates of injury-related hospitalizations and deaths in the North Slope Borough (McAninch 2010). This large burden of injury is partly due to the risks associated with subsistence activities, especially given the often-hostile environment of northern Alaska. Not surprisingly, the Iñupiat have a strong focus on safety. Local history provides numerous examples of both fatal accidents and near misses, the details of which are recounted and dissected to provide warnings and lessons for other hunters. Weather and ice conditions are constant topics of discussion among hunters.

Traditional knowledge provides the base for interpretation of current conditions and risks, and allows for adaptation and responses to help mitigate or avoid the dangers associated with subsistence activities.

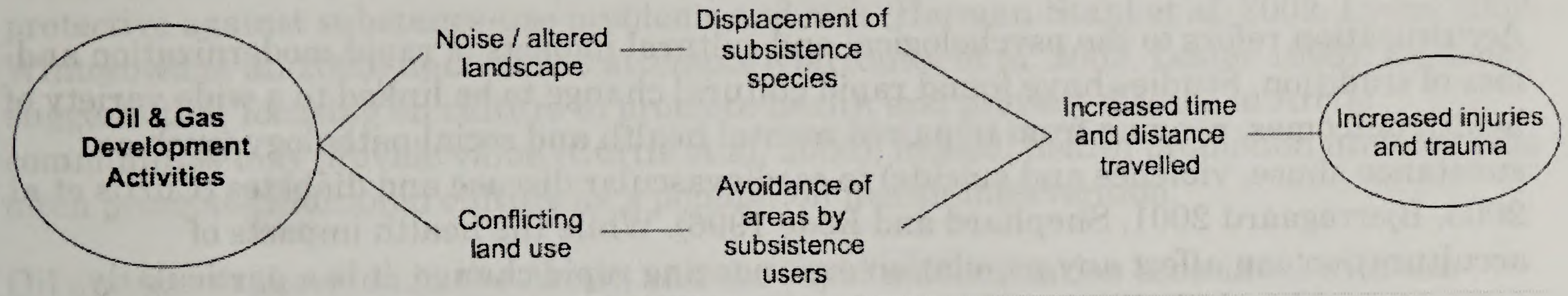
Oil & Gas Development Activities
Noise / altered landscape
Conflicting land use
Displacement of subsistence species
Avoidance of areas by subsistence users
Increased time and distance travelled
Increased injuries and trauma

Figure 4—26. Linkages to safety from oil and gas development activities

Oil and gas development on the North Slope has the potential to increase the already high risk of injuries and accidents occurring during subsistence activities. The disturbance of wildlife by industrial activity, whether from fixed development sites or from transportation, is likely to result in hunters traveling further afield to harvest stocks. Additional time spent traveling by snowmachine or all-terrain vehicle increases the risk of injury in accidents. In addition, traveling farther from camps and villages increases the risk of hunters being caught out on the land in the event of equipment failure or weather changes. Hunters have frequently expressed concern about the potential for displacement of wildlife and the subsequent increased dangers of hunting.

Of particular note is the fact that alterations in travel patterns for subsistence activities occur independently of impacts to wildlife stocks. Existing development to the east of Nuiqsut has resulted in avoidance of a large swath of traditional land for subsistence uses. This impact is discussed in detail in section 4.3.13. The loss of the traditional use of land close to residences and camps, for whatever reason, will increase travel time and isolation and the subsequent risk to the safety of hunters.

The development of permanent and seasonal roads in the region also has the potential to induce travel and raise the risk of subsequent accidents and injuries. This risk is mitigated by the tendency to close private industrial roads to public traffic. Nevertheless, vehicle ownership in the region is high for an isolated indigenous community, due both to the relatively robust local economy and the ability to get vehicles in over land in the winter. As oil and gas development continues and road travel and vehicle ownership rise, so will the risk of motor vehicle accidents and injuries (Ward 2007).

Under Alternative A, the main impact on safety will result from local alterations in travel patterns for subsistence activity. Noise from overflights in any area of exploration or development will cause temporary displacement of caribou and birds, and may require hunters to travel farther from their camps and cabins. These impacts will be localized and temporary, but may intermittently impact a large number of users of the land. Further development of fixed facilities in areas of traditional use is likely to result in voluntary displacement of subsistence activity. The impact of this on safety is of greatest concern when large numbers of hunters avoid significant amounts of territory close to their homes, such as has been the case with the development at Alpine. Any similar development in close proximity to a village will substantially increase travel distances and the subsequent risk of injury. In addition, development associated with a road, particularly if it is publically accessible and brings in outside sport hunters, may result in displacement of and competition for caribou and voluntary avoidance of the area by Iñupiat hunters.

Acculturative Stress

Acculturation refers to the psychological and cultural impacts of rapid modernization and loss of tradition. Studies have found rapid cultural change to be linked to a wide variety of health outcomes, ranging from impaired mental health and social pathology (such as substance abuse, violence and suicide) to cardiovascular disease and diabetes (Curtis et al. 2005, Bjerregaard 2001, Shephard and Rode 1996). While the health impacts of acculturation can affect any population experiencing rapid change, it is a particularly common problem in indigenous populations, including the Iñupiat, other Arctic populations such as the Inuit, and aboriginal populations in Australia (Inuit Tapirisat of Canada 2000, Smylie 2009).

The health impacts of acculturation in the Iñupiat are well documented; for example, the shift away from a nutrient-rich traditional diet and toward store bought and western foods is associated with cardiovascular risk and obesity (Curtis et al. 2005). Similarly, the transition from a traditional to a wage economy and lifestyle may play a role in cardiovascular disease and diabetes in part due to the associated decrease in physical activity (Murphy et al. 1992, Ebbesson et al. 1998, Jørgensen et al. 2002). However, equally if not more important is the loss of the socio-cultural value of subsistence: traditional foods are highly valued among circumpolar populations, as they are considered to be healthy and to provide strength, warmth, and energy in ways that store-bought food do not. Subsistence foods contribute to cultural identity, tradition, and social cohesion. The enjoyment of traditional foods is seen to be of cultural value equal to speaking the native language (Kleivan 1996, Searles 2002).

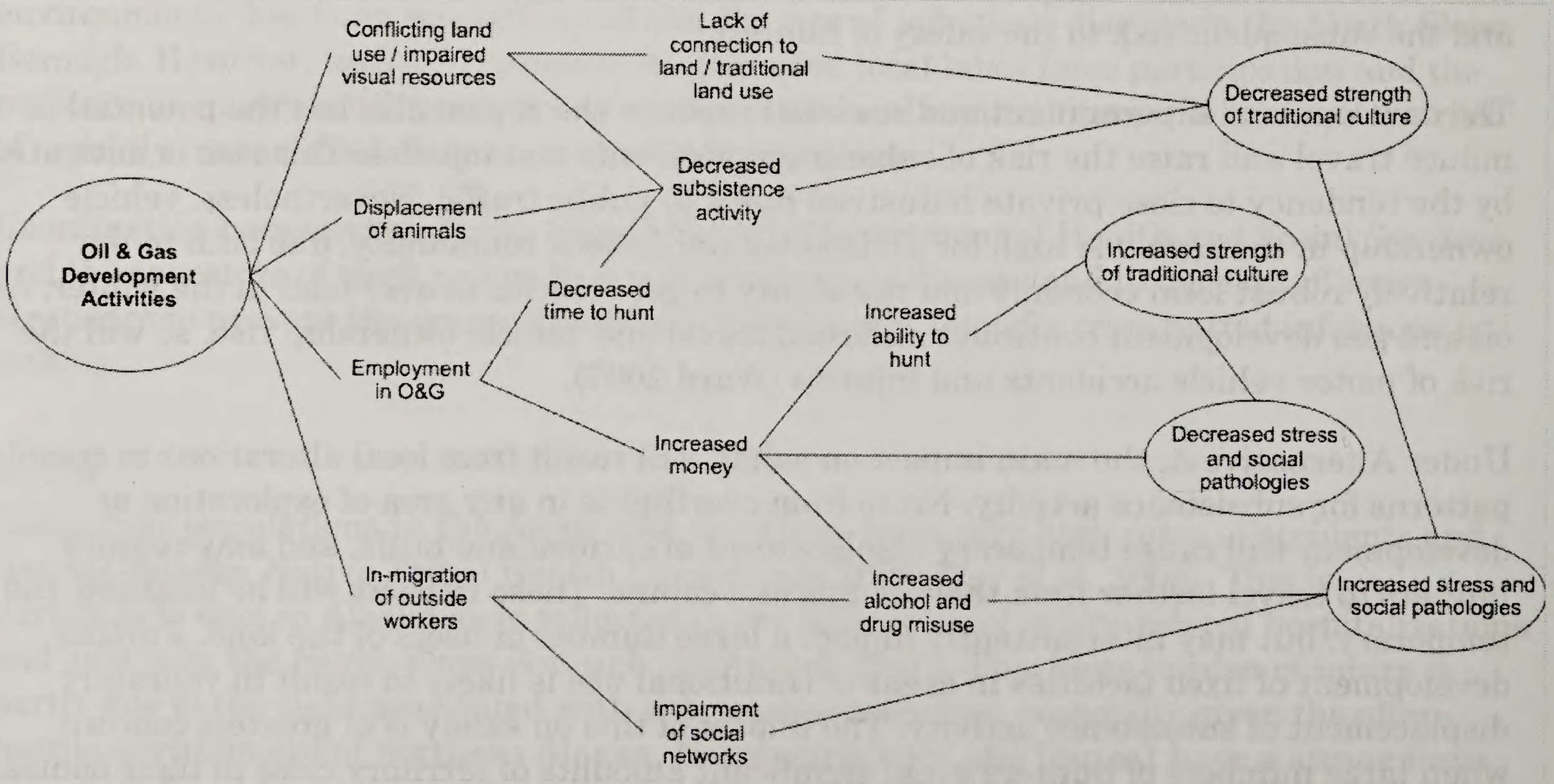
Conflicting land use / impaired visual resources
Lack of connection to land / traditional land use
Decreased strength of traditional culture
Decreased subsistence activity
Displacement of animals
Oil & Gas Development Activities
Increased strength of traditional culture
Decreased time to hunt
Increased ability to hunt
Employment in O&G
Decreased stress and social pathologies
Increased money
In-migration of outside workers
Increased alcohol and drug misuse
Increased stress and social pathologies
Impairment of social networks

Figure 4—27. Linkages to acculturative stress from oil and gas development activities

Identity and involvement in cultural activities provide numerous benefits to Alaska Natives: improved self-esteem (Zimmerman et al. 1996), enhanced resiliency in harsh life circumstances (Belcourt-Dittloff 2006), and diminished feelings of historical loss (Whitbeck et al. 2004). Participation in American Indian traditional activities has been found to be protective against substance-use problems and risk (Herman-Stahl et al. 2002, Lysne 2002, Winterowd et al. 2005) and suicide attempts (Garroutte et al. 2003, Lester 1999). Evidence suggests that focusing on culture to promote health and prevent disease in Arctic communities may provide value (Curtis et al. 2005); indeed, health promotion professionals often promote traditional culture as a population health intervention.

Oil and gas exploration in the Arctic, and the rapid modernization associated with the development of this resource, has led to many of these health issues being observed in the North Slope Borough (Ahtuangaruak 2003, USDOI BLM 2004). Nevertheless, among the Iñupiat the strength of traditional culture and local institutions provide a strongly protective effect against the health impacts of acculturation.

Under Alternative A, the current trends in acculturation and its subsequent health impacts are likely to continue. The isolation of outside workers in segregated work camps and the low levels of direct Iñupiat employment in the oil and gas industry will continue to provide some protection against acculturative stress. Villages where industrial activity occurs in close proximity will be at greatest risk, particularly if there is more open access between the local population and the work camps.

Economic Impacts on Health

Economic growth and employment that are associated with resource development can exert major impacts on the health of populations. On an individual level, employment and income are core determinants of health (Cox et al. 2004). Increased income for individuals or families has the potential to improve health in affected communities through increases in the standard of living, reductions in stress, and opportunities for personal growth and social relationships (Advisory Committee on Population Health (Canada) 1999). Income and employment opportunities may also strengthen community and cultural ties and improve diet and nutrition by providing money to fund subsistence activities. Low income has been associated with increased risk of low-birth-weight babies, injuries, violence, some cancers, and chronic disease (Yen and Syme 1999), while unemployment is associated with increased stress, depression, and anxiety, and is a known contributor to cardiovascular disease (Doyle et al. 2005). In addition, economic disparity—the gap between the well-off and the less well-off in any community—can have a negative impact on the health of all (Marmot 2008).

There are, however, negative impacts of economic growth. With resource extraction projects in rural and remote settings, income and employment have been found to be associated with an increased prevalence of social pathologies, including substance abuse, assault, domestic violence, and unintentional and intentional injuries. Sexual contact between high-wage migratory workers and members of the local communities tends to increase rates of sexually transmitted diseases (Goldenberg et al. 2008). In the Iñupiat, the benefits of employment, particularly in fly-in camp settings, are offset somewhat by tensions created between jobs in the wage economy and subsistence activities (Martin 2005).

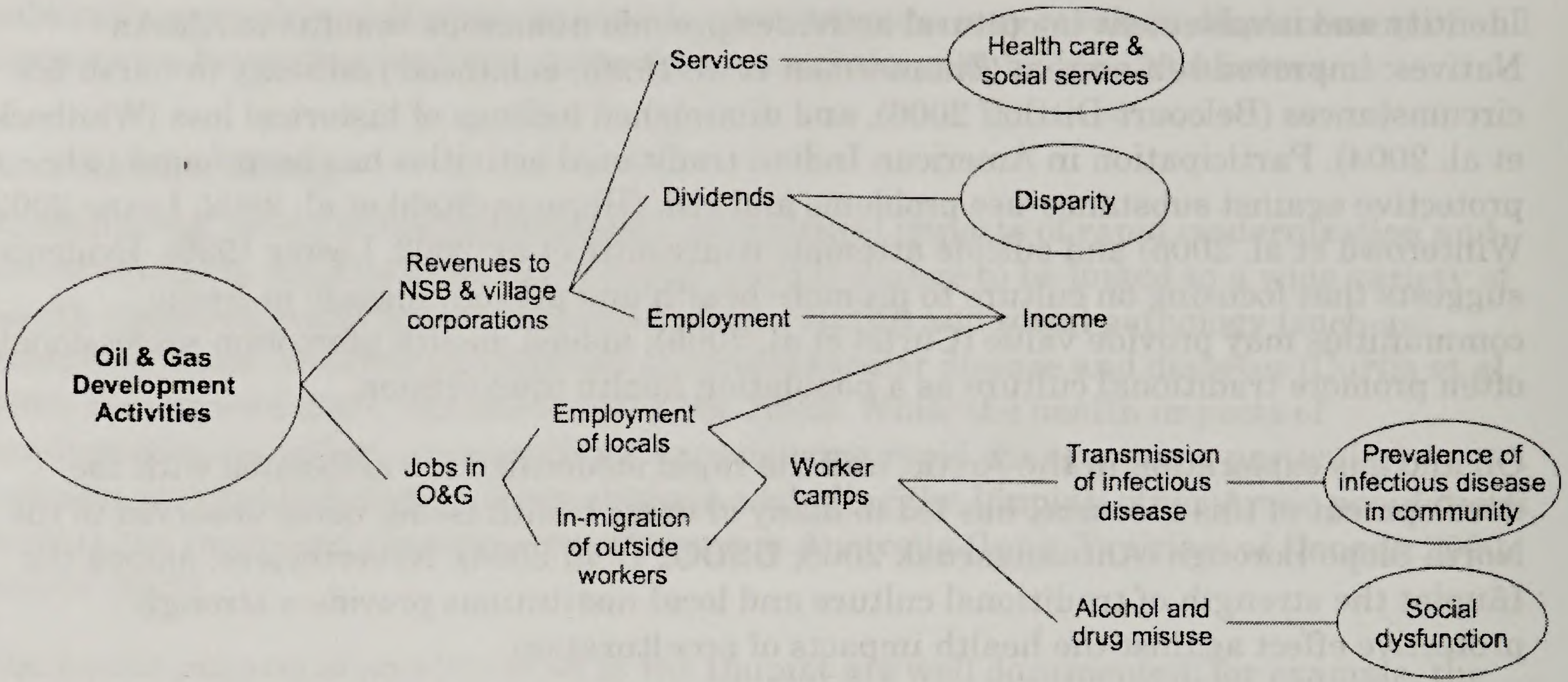
Oil & Gas Development Activities
Revenues to NSB & village corporations
Jobs in O&G
Services
Health care & social services
Dividends
Disparity
Employment
Income
Employment of locals
In-migration of outside workers
Worker camps
Transmission of infectious disease
Prevalence of infectious disease in community
Alcohol and drug misuse
Social dysfunction

Figure 4—28. Linkages to economic health impacts from oil and gas development activities

At present, most oil and gas industry jobs in the North Slope have gone to transient workers housed in camps at Prudhoe Bay or at other exploration or production sites. Isolation of workers in camps helps minimize the negative effects of a migrant workforce, including sexually transmitted diseases and drug and alcohol use. However, as described in section 4.3.20, it may also be partially responsible for the low levels of Iñupiat employment directly in the oil and gas sector. At present, the primary impact of industrial activity on jobs is indirect, largely as a result of revenues to the North Slope Borough and village corporations allowing for increased program spending and hiring.

The health impact of income resulting from direct payments to individuals by way of dividends from village corporations is complicated. While direct monetary disbursements will have a positive impact on those that receive them by way of improved food security and increased affordability of subsistence activities, it can also be associated with social pathology and substance abuse. Moreover, the shareholder structure of village corporations can lead to income disparity when money or jobs are distributed directly to a sub-set of the local population. There are anecdotal reports in Nuiqsut that such disparity between Kuukpik shareholders and non-shareholders has led to tension and resentment in the community (Galginaitis 2006).

Under Alternative A, ongoing revenue to the North Slope Borough and village corporations will allow for the continued funding of existing health and social programs, and the preservation of the current high level of indirect employment. Although new jobs in the oil and gas sector will continue to be created (projections in section 4.3.20), under current conditions it is unlikely that a significant proportion of those jobs will go to Iñupiat workers.

An increase in alcohol and drug use or sexually transmitted diseases is likely to occur in any community through which transient workers pass, with a higher risk of disease transmission associated with a higher volume of workers and degree of intermingling between migratory workers and local residents. Any increase in employment of North Slope residents in the work camps will likely also result in the transfer of these risks back to the workers' home communities. As industrial activity, work camps, and roads spread farther west into the NPR-A, the smuggling of alcohol and drugs, and the resulting social dysfunction and health impacts, will continue to rise. Under Alternative A, the greatest direct impact will be on villages closest to development and with high labor force participation. However, increased individual income and economic activity across the NPR-A under Alternative A is likely to be associated with some increase in alcohol and drug use.

Health Care Services

Resource development has the potential to increase demand on local health and social services, both from the in-migration of workers to an affected area or to an increase in the local burden of disease (Utzinger et al. 2004; Calain 2008; Barron et al. 2010). Outside workers and their families can strain local health resources if services are not provided to them with the development of a project. In addition, resource projects may also directly or indirectly cause the increase of certain conditions, including alcohol and drug-related issues, social pathology, and increased rates of infectious disease (Utzinger et al. 2004; Goldenberg et al. 2008; Barron et al. 2010). When an increase in demand exceeds the capacity of the local services, public health may be affected due to reduced access to and quality of the health care system and social services (Calain 2008; Barron et al. 2010). Resource development projects, however, can have a positive impact on health care services in remote communities when they provide additional tax revenue to the local government (Calain 2008; Barron et al. 2010). To date, on the North Slope, income generated by oil and gas activity has allowed for a well-funded and well-developed set of programs. At the same time, the provision of comprehensive medical services for workers at their camps means that there has been minimal demand on local health care infrastructure from outside workers.

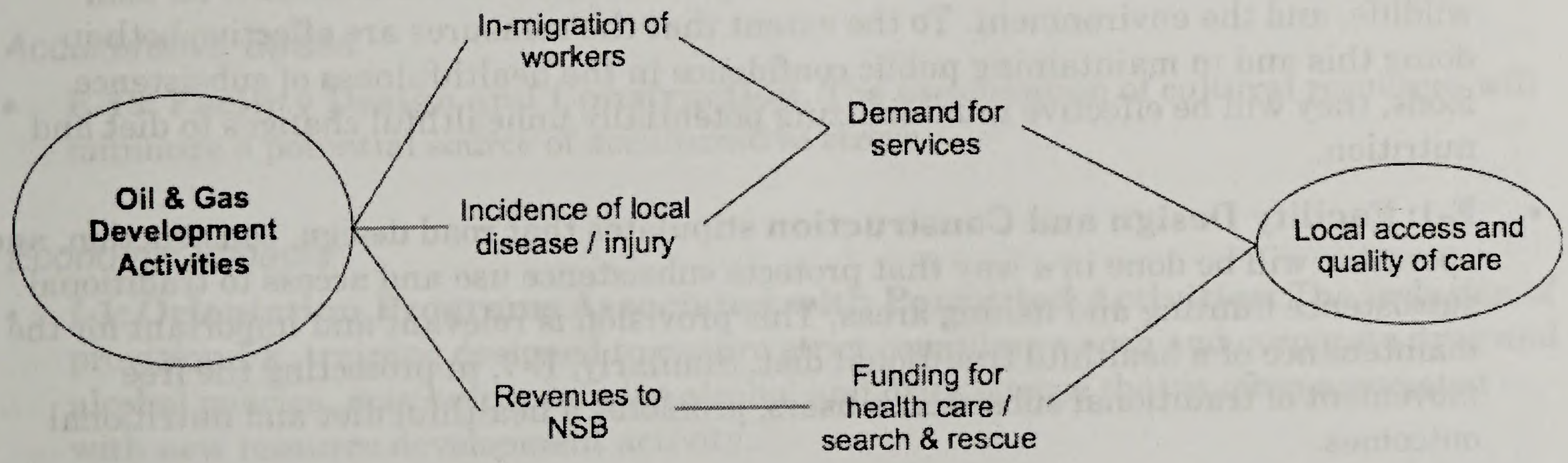
In-migration of workers
Oil & Gas Development Activities
Demand for services
Incidence of local disease / injury
Local access and quality of care
Revenues to NSB
Funding for health care / search & rescue

Figure 4—29. Linkages to health care services from oil and gas development activities

Tax revenues from ongoing exploration and development under Alternative A will support the continued provision of the current level of health care services in the North Slope Borough and should not significantly impact demand. Increased occurrences of injury and trauma (see safety section, above) will be sporadic and will be well within the capacity of acute care and search and rescue services in Barrow. Outside of Barrow, there is limited capacity of the local health care system to respond to any increase in demand. In villages where daily care and emergency treatment is provided by health care aides, any episodic increase in disease occurrence, such as respiratory disease resulting from poor air quality events, has the potential to cause severe short-term strain on the health care system. The likelihood of such an impact under Alternative A is low.

4.3.21.3 Effectiveness of Stipulations and Required Operating Procedures

Alternative A management actions described in Chapter 2 provide a number of important protections for public health and safety.

Public health consultation, which is provided as a management action (see Table 2–2 in Volume 1), and the healthy neighbor policy (see section 2.7 in Volume 1) both recognize the importance of proper consideration of public health impacts, and engagement with local health stakeholder organizations to plan for avoiding, minimizing and mitigating potential health harms and—where possible—enhancing health benefits. As many of the public health impacts of oil and gas development will be project-specific, such management actions are crucial.

The stipulations and required operating procedures that will specifically work to protect or promote public health and safety are listed below. When considering the effectiveness of stipulations in mitigating public health effects, it must be recognized that because the Iñupiat people continue to value this land deeply as a foundation of well-being and culture, any stipulation that contributes to minimizing the environmental impacts of development and preserving and promoting traditional uses of the land can be seen as contributing positively toward overall well-being and public health.

Diet and Nutrition

- **A1-11: Waste Prevention, Handling, Disposal, Spills, and Public Safety.** These protection measures are intended to minimize the impact of contaminants on fish, wildlife, and the environment. To the extent that the measures are effective both in doing this and in maintaining public confidence in the healthfulness of subsistence foods, they will be effective in minimizing potentially unhealthful changes to diet and nutrition.
- **E-1: Facility Design and Construction** stipulates that road design, construction, and operation will be done in a way that protects subsistence use and access to traditional subsistence hunting and fishing areas. This provision is relevant and important for the maintenance of a healthful traditional diet. Similarly, E-7, in protecting the free movement of traditional subsistence users, promotes a healthful diet and nutritional outcomes.
- **H1-H2: Subsistence Consultation for Permitted Activities.** These provisions are key for maintaining adequate and appropriate subsistence use of the land that will support a healthy traditional diet and subsequent nutrition-related outcomes. The fact that subsistence users currently avoid some areas near where oil and gas activities take place-even though hunting remains permitted and subsistence species are present-attests to the importance of the local viewpoint in deciding how subsistence use may best be preserved. The way in which potential conflicts, including the voluntary

avoidance of traditional lands, between subsistence users and oil and gas operators are resolved and not merely documented will also be important.

Environmental Exposures

- **A1-11: Waste Prevention, Handling, Disposal, Spills, and Public Safety.** These required operating procedures are essential in preventing or reducing public exposure to chemical, physical, or biological hazards, and thus, ensuring public health and safety.
- **E-4: Facility Design and Construction.** The requirement for pipelines to be designed, constructed, and operated in a way that minimizes the potential for leaks is similarly important in preventing or reducing public exposure to contaminants, either directly or via contamination of food sources.

Infectious Disease

- **A1-11: Waste Prevention, Handling, Disposal, Spills, and Public Safety.** The biological waste management practices described in these required operating procedures will reduce the likelihood of gastrointestinal disease transmission.
- **I-1: Orientation Programs Associated with Permitted Activities.** The inclusion of provision I-l, which specified training on preventing transmission of communicable diseases, including sexually transmitted diseases, may be significant in preventing worker-related infectious disease outbreaks in the community.

Safety

- **A1-11: Waste Prevention, Handling, Disposal, Spills, and Public Safety.** These provisions will also help ensure public safety through the minimization of potential exposure to hazardous toxic substances.

Acculturative Stress

- **E-13: Facility Design and Construction.** The preservation of cultural resources will minimize a potential source of acculturative stress.

Economic Impacts

- **I-1: Orientation Programs Associated with Permitted Activities.** The inclusion of provision I-k, training designed to ensure strict compliance with and corporate drug and alcohol policies, may help minimize alcohol and drug misuse that is often associated with new resource development activity.

Taken in whole, the stipulations and required operating procedures for Alternative A will directly and indirectly promote public health and safety during oil and gas development activities, and partially mitigate some of the adverse health pathways anticipated under Alternative A.

4.3.21.4 Conclusion

Under Alternative A, the general trends in public health in the North Slope Borough will continue. The transition in the burden of disease from one in which infectious disease predominated to one in which chronic disease is the primary driver of ill health will progress among the Iñupiat as it has in other indigenous populations. As is the case with other subsistence-dependent Arctic regions, injuries and trauma will continue to carry a disproportionate share of morbidity and mortality when compared to the general Alaska and U.S. populations, and the risk of injury and trauma may also be exacerbated if climate change results in unusual or unpredictable weather, water, snow, and ice conditions that make travel more hazardous (Brubaker 2011), and dislocation of subsistence species require people to travel greater distances to find marine or land mammals or edible plants.

Oil and gas activities contribute to these trends and impact public health in a number of ways. The preservation and promotion of traditional uses of the land is a public health priority, both for the nutritional benefits associated with a subsistence diet and for the social cohesion and cultural value associated with traditional Iñupiat practices. Though economic development provides important health benefits through both individual employment and revenues to local governments, these benefits are balanced against the risks that result from an erosion of traditional culture and diet and exposures to environmental contaminants, social ills and infectious disease.

Under Alternative A, localized exploration activity will create transient impacts on subsistence by diverting hunters and animals. In addition, noise from air traffic and other sources will create a nuisance around individuals' camps and cabins. Potential contamination of food and surface water is possible, though measurable public health impacts resulting from such contamination are unlikely under normal operating conditions. However, the perception of contamination of traditional foods is already a problem in the region. Further development may worsen this perception, and could exacerbate the shift away from a subsistence diet.

Fixed production sites, particularly those in the vicinity of villages and in areas of heavy subsistence use of the land, will have an impact on public health under Alternative A. The avoidance of developed areas by hunters increases travel times and costs associated with subsistence activity, and as a result, will potentially decrease harvests and increase the risk of injury and accidents while on the land. Episodes of poor air quality associated with dust or emissions will pose a health hazard for at-risk populations such as those suffering from chronic obstructive pulmonary disease or asthma.

The economic impact of activity under Alternative A will allow for a continuation of funding for current levels of services and maintenance of the current level of indirect employment, particularly through the North Slope Borough. Given current conditions, it is unlikely that new employment for the Iñupiat in the oil and gas sector will be significant enough to cause public health impacts. The health risks associated with economic growth and in-migration, namely increased use and access to alcohol and drugs and the spread of infectious disease and sexually transmitted diseases will be commensurate with the level of employment, road access, and the degree to which outside workers fraternize with local populations. The continued focus on the development of isolated work camps will temper these impacts.

4.3.21.5 Potential Mitigation Measures

Potential Mitigation Measure 1—Infectious Disease (new required operating procedure)

Objective: Minimize likelihood of and impacts from infectious disease spreading among the local population as a result of contact with transient oil and gas workers.

Requirement/Standard: In consultation with appropriate experts, including the North Slope Borough Department of Health and Social Services, developers and operators of permanent infrastructure that will host 10 or more employees simultaneously shall develop a comprehensive plan to prevent outbreaks of infectious disease and the spread of sexually transmitted infections in workers and in work camps. Management decisions pertaining to infection control shall be addressed in the following order of priority: (1) prevention, (2) identification of cases in workers, (3) treatment, and (4) tracing of contacts. The plan shall consider the use or establishment of the following:

a. Hand-washing stations and information in communal areas of work camps, including cafeterias, washrooms, and recreation areas.

b. Peer-to-peer education and workshops to address stigma and promote sexual health in order to increase safe-sex practices and the uptake of testing.

c. Targeted awareness campaigns and free condoms in medical consultation / first-aid rooms, washrooms, and other locations in work camps. .

d. Ongoing immunization against seasonal influenza and other vaccine-preventable communicable diseases.

e. Where drug formularies are available in camps, inclusion of antibiotics for chlamydia and gonorrhea.

f. Where developers / operators employ occupational health providers, the use of personnel trained in the identification of common sexually transmitted infections and the collection and testing of samples; in work settings without health care providers, provision of the means for self-specimen collection and self-testing.

g. Where developers / operators employ health providers, the use of personnel trained in contact tracing and liaise with the North Slope Borough for notification and treatment of local sexual contacts of workers with sexually transmitted infections.

h. Reporting of significant outbreaks of infectious disease in camps, such as influenza or gastrointestinal disease to the North Slope Borough Department of Health and Social Services and to the Alaska Department of Health and Social Services. During episodic outbreaks (such as seasonal influenza) or unique events (such as pandemic influenza), consideration of coordination of surveillance and testing with the North Slope Borough.

Potential Benefits and Residual/Unavoidable Impacts: Primary prevention, combined with case identification and early treatment, should reduce the prevalence of sexually transmitted infections and other infections in the workforce and the transmission of these diseases into the local population. Coordination with local service providers will help ensure an effective response to sporadic infections and episodic outbreaks.

Potential Mitigation Measure 2—Alcohol and Drug Use (new required operating procedure)

Objective: Minimize likelihood of and impacts from the importation of alcohol and drugs into local communities from work camps or via seasonal or permanent roads.

Requirement/Standard: In consultation with appropriate experts, including the North Slope Borough Department of Health and Social Services, developers and operators of permanent infrastructure that will host 10 or more employees simultaneously shall develop a comprehensive plan to prevent the abuse or trafficking of alcohol or drugs. The plan shall consider the following:

a. Investigations in cooperation with North Slope Borough police if a development appears to be associated with an increased prevalence of alcohol and drugs in nearby communities.

b. Surveillance on company roads, whether seasonal or permanent, for use by individuals transporting alcohol and drugs for use by residents of the North Slope Borough. Surveillance operations should consider methods to avoid the harassment of local population engaged in subsistence activities or other travel.

c. Evaluation of steps to ensure that the possession of alcohol or drugs in work camps not create the potential for trafficking to local communities and ensure the reporting of such potential to the appropriate North Slope Borough agency.

Potential Benefits and Residual/Unavoidable Impacts: Work camps and migration of workers from areas with easier access to alcohol and drugs can be a source of importation into local communities. In addition to best practice standards for occupational health and safety regarding alcohol and drug use, policies addressing the potential for trafficking will help prevent and intercept substances destined for local communities. However, regardless of policies, some importation will persist. In addition, income from jobs or other disbursements may increase local drug and alcohol use, regardless of the route of importation.

Potential Mitigation Measure 3—Employment (new required operating procedure)

Objective: Maximize the health benefits associated with occupational training and employment by increasing the rate of direct employment of North Slope residents in the oil and gas industry.

Requirement/Standard: Developers and operators of permanent infrastructure that will require 10 or more employees are encouraged to engage in expanded outreach, recruitment, and job opportunity awareness with respect to North Slope resident workers in consultation with the North Slope Borough and village corporations and to develop placement goals, as defined by the federal government, for local resident participation.

In consultation with the North Slope Borough, developers and operators of permanent infrastructure that will require 10 or more employees shall develop a comprehensive plan to increase the recruitment and retention of North Slope resident workers in meaningful employment. The plan shall consider the following:

a. Working with village corporations to identify and develop the necessary training and certification programs to enable residents to apply for a variety of jobs within the oil and gas sector. When such training programs cannot be locally provided, provisions consideration should be given to external training of suitable candidates.

b. Scheduling of shifts for the unique lifestyles of local workers, including the consideration of shorter-duration stays in work camps for workers from the North Slope Borough and subsistence leave for hunters employed in the oil and gas sector.

c. Making work and camp environments welcoming to North Slope resident workers, including providing cultural training for managers and co-workers and training of community liaison workers or human resource staff to identify conflicts affecting retention of North Slope resident workers.

Potential Benefits and Residual/Unavoidable Impacts: Direct employment in the oil and gas industry provides immediate health benefits though income and self-worth, and the skills and experience acquired may be parlayed into future jobs and career development. However, there are many barriers to employment of the Iñupiat in the industry, and low rates of direct employment persist, despite significant training and recruitment efforts in the past.

Potential Mitigation Measure 4—Siting of Work Camps (new required operating procedure)

Objective: Balance the health risks that migrant workforces and work camp environments are known to bring to neighboring communities, with the potential benefits that may accrue from closer integration.

Requirement/Standard: In consultation with the NSB and relevant village leadership (such as the Tribal Council, the City Council, the Mayor, ANCSA village corporation officers, the Subsistence Oversight Panel, village health providers, and/or elders of the community, ANCSA village corporation and village city and tribal official), developers and operators of permanent infrastructure that will host 10 or more employees simultaneously shall develop a comprehensive plan on the siting of work camps. When a decision is made to site a camp in close proximity to a village (defined as areas that fall within the North Slope Borough's Comprehensive Plan for each village), a site management plan shall consider the following:

a. Fraternization between workers and local residents should be minimized. If there is a direct road connection between a village and a work site, consider actively managed gates.

b. Any sites that house workers will follow the same infectious disease and alcohol and drug management plans as camps.

c. Travel through villages to worksites will be kept to a minimum.

d. Monitoring by the North Slope Borough for increases in sexually transmitted infections, outbreaks of communicable diseases, and increases in drug and alcohol use should be undertaken. The North Slope Borough and the camp operators should communicate regarding any detected problems and develop joint response strategies.

Potential Benefits and Residual/Unavoidable Impacts: The siting and operation of work camps can lead to fraternization between employees and local residents, increasing the risk of conflict, alcohol and drug use, and infectious disease. Isolated camps with limited access can decrease these risks, particularly when combined with specifically targeted mitigations. However, in some situations, a community may want increased access to a camp for the purposes of employment, revenue, infrastructure, or other ancillary benefits. Any increase in contact will increase risk; however, such risk can be managed.

Potential Mitigation Measure 5—Public Health Monitoring (new required operating procedure)

Objective: To minimize the effects of harmful oil and gas development-related changes to population health.

Requirement/Standard: A public health monitoring program should be created at a regional level to track health indicators that are vulnerable to impacts from oil and gas activities. These indicators should focus on health outcomes and/or determinants of local concern that can be tied to oil and gas activity. Where possible, indicators should include threshold levels and specific actions should be developed for when thresholds are surpassed. The State should be responsible for the development and implementation of the monitoring program; however the North Slope Borough and the Alaska Native Tribal Health Consortium should be consulted in the identification of appropriate indicators, thresholds, and responsive actions.

Potential Benefits and Residual/Unavoidable Impacts: The public health monitoring program will expedite the detection of unacceptable changes in population health caused by oil and gas activity. The sooner health changes are detected, the greater the likelihood of avoiding controversial and devastating impacts that will not only impact the communities, but that will greatly harm the relationship between the communities and the State. However, a monitoring program will detect, but cannot by itself, eliminate any negative changes in public health that may result from oil and gas development.

Potential Mitigation Measure 6—Environmental Contamination (new required operating procedure)

Objective: To reduce negative impacts to human health though exposure to contaminants and the stress and dietary changes that are associated with the perception of contamination.

Requirement/Standard: Lessees and permittees should work in collaboration with the North Slope Borough and village subsistence oversight panels to ensure that the environmental media, including air, water, and traditional food sources, remain safe and that local populations continue to trust in their safety. This approach should include the following requirements:

a. Support for all mitigation measures listed for prevention of contamination of subsistence resources (e.g., A-10, A-11)
b. Communication of the results of monitoring programs should include information about contaminants placed in the context of the nutritional benefits of traditional food. Messaging should be coordinated with the North Slope

Borough Department of Health Social Services and local subsistence oversight panels.

c. Collection of air quality data at industrial sites must be provided to the North Slope Borough and to local communities in a timely manner and in a useable form.

Potential Benefits and Residual/Unavoidable Impacts: Reducing exposure to environmental contaminants will result in the avoidance of any associated disease development. Reducing perception of environmental contamination through appropriate communication will result in the avoidance of temporary or permanent anxiety and changes in diet-related behaviors. However, a certain amount of environmental contamination is an inevitable consequence of oil and gas development, which creates the potential for permanent or persistent changes in public health commensurate with the degree of contamination.

Potential Mitigation Measure 7—Oil Spills (new required operating procedure)

Objective: To minimize negative health impacts associated with oil spills.

Requirement/Standard: If an oil spill occurs, agencies involved in the coordination of response will ensure the following potential health consequences are considered:

a. Immediate health impacts and responses for affected communities and individuals.

b. Long-term monitoring for contamination of subsistence food sources.

c. Long-term monitoring of potential human health impacts.

d. Perceptions of contamination and subsequent changes in consumption patterns.

e. Health promotion activities and communication strategies to maintain the consumption of traditional food.

Potential Benefits and Residual/Unavoidable Impacts: Oil spills are a key concern among stakeholders in the North Slope Borough. This effort to minimize the impact of an oil spill will greatly reduce potentially large health impacts that could result through contamination as well as through destruction of subsistence food sources. However, in a very large oil spill, some contamination-related health impacts may persist. In addition, perception of contamination is likely to have a persistent impact on the consumption patterns of traditional foods that could exacerbate the health risks associated with the transition to a western diet.

Section 4.4:

Impacts of Alternative B-1

4.4 Alternative B-1

4.4.1 Air Quality and Climate

This section qualitatively describes the potential air quality impacts associated with Alternative B in the Draft IAP. The BLM is preparing an air emissions inventory and a dispersion modeling analysis to refine this qualitative analysis.

4.4.1.1 Activities Not Associated With Oil and Gas Exploration and Development

Air quality impacts associated with these activities are the same as those associated with Alternative A, discussed in section 4.3.1.1.

4.4.1.2 Oil and Gas Exploration and Development Activities—Air Pollutant Emission Sources

The air pollutant emission sources and effects of air pollution are the same as those associated with Alternative A, discussed in section 4.3.1.2.

Development and production activities can also produce fugitive dust emissions (primarily as PM_{10}). Fugitive dust occurs primarily during the summer months due to driving on unpaved roads. Vehicles can also track out fine material from gravel mining operations in the winter and summer months. Potential control measures include limiting vehicle speeds, and treating problematic road sections with surfactants or water.

Well closure, abandonment, and reclamation activities would emit air pollutants similarly to those during development (construction), since similar vehicles and other emission sources would be used. Because closure activity would not occur at a single location for any substantial length of time, the impact of air emissions at any single location would likely be minor and short term. Impacts could be minimized by leaving gravel on-site, limiting the amount of transport. Once reclamation is complete, production facilities would no longer impact air quality in the planning area (2008 Northeast NPR-A Supplemental IAP/EIS).

4.4.1.3 Effectiveness of Stipulations and Best Management Practice

Best Management Practice A-9 requires that all oil and gas operations that burn diesel fuels use ultra-low sulfur diesel as defined by the Alaska Department of Environmental Conservation-Division of Air Quality. Effective December 1, 2010, the Alaska Department of Environmental Quality adopted the EPA regulation that requires the use of ultra-low sulfur diesel fuel in all vehicles and equipment. This requirement would apply to all BLM-authorized oil and gas operations (including contractor vehicles and equipment).

Consistent with 40 CFR Part 69, beginning on December 1, 2010, the diesel fuel that is designated for use in rural Alaska for all on-road and non-road vehicles and equipment, locomotive, and marine will be ultra-low sulfur diesel fuel (15 parts per million sulfur). Ultra-low sulfur diesel became designated for use for on-road vehicles in urban Alaska on October 15, 2006; for non-road vehicles and equipment on December 1, 2010; and will be designated for locomotive and marine vehicles on December 1, 2012. Urban Alaska is those geographical areas of Alaska designated by the State of Alaska as being accessible by the

Federal Aid Highway System. Areas not accessible by the Federal Aid Highway System are rural (Elson 2011).

As a trace constituent in diesel fuel, sulfur compounds may cause adverse air quality impacts through formation of sulfate particulate matter (affecting visibility) and deposition of acidic aerosols. These impacts would be reduced significantly by utilizing ultra-low sulfur diesel fuel. In addition, ultra-low sulfur diesel fuels burn cleaner and produce less light absorbing carbon particulate matter (soot, also called black carbon). When burned, ultra-low sulfur diesel emissions are much lower than those generated by previous fuels, reducing fine particulate (soot), sulfuric acid, and sulfate (visibility) impacts.

4.4.1.4 Conclusion

Emissions and resulting air quality impacts from Alternative B-1 are expected to be the lowest compared to the other alternatives due to substantially less federally owned subsurface being available for oil and gas leasing compared to Alternatives C and D, and slightly less compared to Alternative A. As a result, air pollution would be roughly proportionately reduced compared to the other alternatives.

4.4.2 Paleontological Resources

4.4.2.1 Activities Not Associated With Oil and Gas Exploration and Development

Under Alternative B-1, the types of non-oil and gas activities would be the same as those described for Alternative A (section 4.3.2.1), and the potential impacts to paleontological resources would also be similar.

4.4.2.2 Oil and Gas Exploration and Development Activities

Effects of Seismic Surveys

Under Alternative B-1, the level of seismic activity could increase slightly over that of Alternative A (4.3.2.2) in regard to 3-D activities. It is anticipated that there could be an increase of as much as 4,456 survey/camp train miles, about 8 percent, and 43,345 surveying/camp train acres, (8 percent). However, given the low probability of impact from seismic activity, this is not regarded as a meaningful increase in terms of potential impact to paleontological resources. Therefore, the probability of encountering and impacting scientifically significant paleontological material under Alternative B-1 remains low.

Effects of Short-term Disturbance: Exploration and Delineation Drilling

Short-term-impact-producing activities that include drill pads, roads, and airstrips constructed of ice and snow would total 233,478 acres. Under Alternative B-1, all of these activities are reduced by about 29 percent compared to Alternative A (section 4.3.2.2). Under Alternative A, the potential adverse impact to paleontological resources from short-term disturbance is low. Under Alternative B-1, where less land is available for leasing and the amount of potentially impacting activities is substantially reduced, the potential for adverse impact remains low.

Effects of Long-term Disturbance: Development of Oil and Gas Infrastructure

Under Alternative B-1, the amount of potential disturbance from construction of central processing facilities and associated satellite pads, roads, airstrips, pump/compressor stations, and gravel pits in regard to surface area is reduced to 7,505 acres, about 2,400 acres (24 percent) and a reduction of approximately 10 million cubic yards (25 percent) of gravel mined compared to that of Alternative A. Also by comparison, the number of potential vertical support members is reduced to 49,005 (26 percent less than Alternative A). Meanwhile, gas pipeline trenching would increase by 57 miles (9 percent) adding 228,000 cubic yards to the total excavated material. Overall, excavation, the activity that is most likely to adversely impact paleontological material, would be reduced substantially under Alternative B-1.

Effects of Oil Spills and Gas Releases

Under Alternative B-1, the effects of spills on paleontological resources would be essentially the same as discussed under Alternative A. However, since there would be fewer wells drilled and less infrastructure developed under Alternative B-1, the probability of encountering and impacting paleontological material is reduced. As previously described (section 4.3.2.2), there would probably be no adverse effect on paleontological resources from a gas release.

Effects of Abandonment and Reclamation

Abandonment and reclamation of short-term and long-term infrastructure, under most circumstances, would have limited if any impact on paleontological resources (see section 4.3.2.2).

4.4.2.3 Effectiveness of Stipulations and Best Management Practice

Under Alternative B-1, the primary safeguard for paleontological resources is Best Management Practice E-13, which states that lessees will conduct a paleontological resources survey prior to engaging in any potential ground-disturbing activity.

4.4.2.4 Conclusion

The primary potential impact to paleontological resources would result from the excavation of gravel for construction of the permanent facilities. However, surveys for paleontological resources are required to be conducted before excavation or any potential ground-disturbing activities could take place. Considering the variability of distribution, density, and context of paleontological resources in the NPR-A and the overall effectiveness of the protection, non-oil and gas and oil and gas activity have a very low probability of adversely impacting paleontological resources. The potential effect of climate change is the same as described for Alternative A.

4.4.3 Soil Resources

4.4.3.1 Activities Not Associated with Oil and Gas Exploration and Development

Various types of activities not related to oil and gas leasing and development, including private or commercial air traffic, summer research camps, use of off-highway vehicles, recreational camps, paleontological and archaeological excavations, and overland moves could affect soil resources in the planning area under Alternative B-1.

Under Alternative B-1, impacts associated with non-oil and gas activities would be similar to those described under Alternative A. These activities could occur throughout the planning area and would be little affected by the decreased availability of land for oil and gas leasing.

4.4.3.2 Oil and Gas Exploration and Development Activities

The following analysis is based on section 4.2.1.2, "Oil and Gas Exploration and Development Activities." See that section for a discussion of estimates and assumptions for development, as well as a description of how estimated areas of disturbance were calculated for each alternative.

During oil and gas exploration and development, various activities could cause impacts to soil resources in the planning area. These activities include seismic activities; construction and use of gravel pads, gravel roads, gravel airstrips, and pipelines; excavation of material sites; construction of ice roads and ice pads; and summer tundra travel. Impacts could also occur from oil spills and from removal of gravel pads and gravel roads during reclamation. These activities would impact soil productivity and could alter the moisture regime of tundra near the structure by changing natural drainage patterns and areas where snow accumulates and amount of heat that is absorbed by the surrounding areas. Types of impacts to soil resources for Alternative B-1 would be similar to those described for Alternative A. Descriptions of differences in the magnitude and area of impacts for Alternative B-1 are below.

Effects of Disturbances

Seismic Surveys

Effects to soils from seismic surveys would be the same as for Alternative A. Under both alternatives, it is projected that one 2-D and 10 3-D surveys would be done to fill in gaps in existing survey and monitor remaining reserves. Since vegetative cover would be minimally impacted, soil disturbance is projected to be minimal. Short-term soil disturbance from 2-D and 3-D operations combined would total a maximum of 581,397 acres (2.5 percent of the 22.8 million-acre NPR-A). Long-term disturbance to soils total approximately 1,670 acres.

Exploration

Under Alternative B-1, impacts to soil from activities associated with oil and gas exploration would be similar to those described for the Alternative A. It is anticipated that under Alternative B-1 there would be fewer exploration and delineation wells drilled, which would result in lower impacts to soil resulting from the construction of multi- and single-year ice pads (6 acres each), ice roads, and well collars.

During the life of the plan, it is assumed that 64 exploration wells and the same number of delineation wells, or a total of 128 wells for both oil and gas, would be drilled from ice pads in the NPR-A under Alternative B-1. At 6 acres per pad, 768 acres of tundra spread out over 30 years would be impacted (a reduction of 35 percent, compared to Alternative A).

Under Alternative B-1, ice road and snow trail construction would also be less than in Alternative A in terms of total miles. The total acreage of short-term disturbance from ice roads and snow trails over 30 years would be 231,995, about 28 percent less than for Alternative A. Since soil disturbance is minimal, recovery from ice road impacts is expected within a few years (Yokel et al. 2007); long-term disturbance from ice roads would be negligible. Although some evidence of crushed tussocks may still be apparent, new growth would preclude any exposed soils.

Ice airstrips are also used during exploratory drilling, and under Alternative B-1, it is assumed that 65 ice airstrips would be constructed, covering 11 acres each for a total of 715 acres (35 percent less than under Alternative A). These airstrips are commonly built on the grounded ice of large lakes, but if they were built over tundra, they would result in impacts similar to ice roads.

The construction of well cellars during exploration requires the digging of a hole that destroys soil on approximately 64 square feet (0.0015 acre) of ground. Thermokarst associated with the disruption of thermal regime in the surrounding soil may also change the soil properties type around the well cellar to a wetter regime. These impacts could result in 0.2 acre of soil being destroyed under Alternative B-1 (50 percent less than under Alternative A).

Development and Production

During oil and gas development and production, various activities could cause impacts to soils in the NPR-A. These activities include construction and use of gravel pads, roads, airstrips, and pipelines; excavation of material sites; and construction of ice roads and ice pads. Ice roads and pads are covered above.

Placement of Gravel Fill

Types of impacts to soils from placement of gravel fill would be similar to those in Alternative A. Construction of central processing facilities and central gas facilities with associated satellite pads, roads, staging areas, and airstrips, one compressor station and three staging bases would be developed, resulting in the loss of soil productivity in the areas of gravel placement. Under this alternative, it is estimated 5,037 acres of soils buried by gravel placement (29 percent less than under Alternative A).

The decreased facilities construction and use under Alternative B-1 would result in a smaller area impacted by dust than under Alternative A. Assuming a total of 496 miles of in-field gravel roads and 27 airstrips (25.6 miles), there is a potential for a total perimeter of 1,043 miles. Within 30 feet of gravel fill, up to 3,793 acres could be subject to loess soil depositions by dust and gravel, and another 15,174 acres could be affected by a dust shadow that affects out to 150 feet.

Construction of central processing facilities and associated gravel pads, roads, staging areas, and airstrips could alter the moisture regime of tundra near the structure by changing natural drainage patterns and areas where snow accumulates. Snowdrifts caused by gravel structures would increase the wintertime soil surface temperature and increase thaw depth in soils near the structures. Dust deposition and the formation of impoundments would exacerbate these impacts. These factors could combine to warm the soil, deepen thaw, and produce thermokarst adjacent to roads and other gravel structures (National Research Council 2003). In flat, thaw-lake plains on the North Slope, gravel construction can be anticipated to result in upslope water impoundment and thermokarst erosion equivalent to the area directly covered by gravel (Walker et al. 1987). In general, most changes in the soil profiles around gravel structures would occur within 164 feet of the structure. If all effects were to occur within this zone, a maximum of 20,737 acres would be impacted under Alternative B-1 (30 percent less than under Alternative A). Note that this area includes the 18,967 acres affected by dust above, and is not in addition to it.

Material Sites

Gravel required for development in the planning area could be mined from existing sites east of the NPR-A or could be extracted from new sites developed within the planning area. Investigations to identify gravel sources in the planning area have not been conducted, but presumably would be initiated if discoveries of recoverable oil or gas were made. Under Alternative B-1, it is assumed that up to 29 material sites would be needed, covering a total area of 1,007 acres (29 percent less than under Alternative A). Excavation of the gravel mine and stockpiling of overburden would remove soil and impact soil productivity at these sites.

Pipelines

Under Alternative B-1, given the potentially fewer number of fields developed, impacts from pipeline construction would be less than those described for Alternative A. Pipelines on the North Slope are typically built on vertical support members with a diameter of 12 inches and a spacing of 150 vertical support members per mile. About 6 percent of this area would have soils replaced by the vertical support members, and the remaining portion would be potentially altered in terms of soil profiles and composition. Approximately 0.05 acre of soil would be disturbed per pipeline mile for oil gathering pipelines, and 0.03 acre per mile of regional oil pipelines. Under Alternative B-1, 154 miles of gathering lines for oil, and 451 miles of regional oil pipelines would disturb about 20 acres of soil through vertical support member placement, or about 26 percent less than under Alternative A. Ice roads built for construction of these pipelines would have short-term impacts to soil on less than 2,565 acres. In reality, some of the vertical support members for gathering lines would be over gravel pads and would have no additional impacts on soils, nor would ice roads be necessary for construction of these portions of pipeline. It is assumed that gas pipelines would be buried, so impacts to soils would be different than for oil pipelines. In the case of buried gathering, regional and high-pressure gas pipelines, short-term disturbance from ice roads would affect 5,194 acres. Long-term impacts from trenching and spoils storage would occur on 1,559 acres.

Summer Tundra Travel

On a case-by-case basis, the BLM may permit low-ground-pressure vehicles to travel off gravel pads and roads during periods other than when the ground is frozen and covered with snow. This would be an uncommon occurrence, and if permitted at all, it would likely be only during late summer to fall. Because of restrictions on this activity, impacts to soils should be limited to the compression of standing vegetation, similar to what happens during winter following traffic by low-ground-pressure vehicles. Some of these uses may adversely affect small areas of wet ground, in particular, causing changes in vegetative cover that may initiate subsidence along the travelled route.

Summer vehicle tundra travel is commonly associated with spill prevention and preparedness measures required in spill prevention plans. Each summer season, low-ground-pressure vehicles might be used to transport and place booms across streams downstream from pipelines. These booms are left in place through the summer to capture any oil that might spill from a pipeline and then would be retrieved, again probably using low-ground-pressure vehicles, before freeze-up. Pipeline inspections may also entail summer vehicle travel on the tundra. Finally, periodically, spill response training may occur along and downstream from pipelines in summer.

As a rule, summer tundra travel for exploration and development would not be permitted under Alternative A. Therefore, given the potentially fewer number of fields developed and allowance of summer tundra travel under certain circumstances, impacts from summer tundra travel under Alternative B-1 should be greater than in Alternative A. Short-term, minor impacts to soils are expected from limited summer tundra travel using low-ground-pressure vehicles. However, Best Management Practice L-1 is designed to regulate and monitor summer travel and minimize impacts to soils and vegetation. Summer travel would only be permitted on a case-by-case basis if the applicant can demonstrate that the proposed use would have no more than minimal impacts to soils and vegetation.

Abandonment and Reclamation

Types of impacts from abandonment and reclamation would be the same as those described in Alternative A. Under Alternative B-1, it is expected that fewer structures would be constructed for oil and gas activities as compared to Alternative A (Table 4-14). Therefore, the amount of reclamation required, and impacts to soils from abandonment and reclamation, would be less than under Alternative A.

Effects of Oil and Gas Development on Permafrost

Types of impacts to permafrost from oil and gas development would be the same as those described in Alternative A. Under Alternative B-1, less surface disturbance is expected from oil and gas activities as compared to Alternative A. Therefore, there would be less area of permafrost potentially affected.

Effects of Spills

Effects of spills on soils would be similar to those in Alternative A. Under Alternative B-1, impacts to soils from oil spills could be somewhat less than in Alternative A, as the estimated number of large and small spills is slightly lower (see section 4.2.2.1, "Oil

Spills"). The probability of a large oil spill occurring would also be less under Alternative B-1; but for analysis, the assumption remains at one large spill.

Most oil spills cover less than 500 square feet (less than 0.01 acre); although a pressured aerial mist may cover up to 145 acres (Ott 1997). (Such a spill is a very low probability event, occurring less than once out of the total spills expected throughout the life of this plan. Thus, its magnitude is not apparent in the following acreages.) If 11 percent of all oil spills would reach soil during summer, under Alternative B-1 this would mean 40 of the 368 crude and refined oil spills assumed to occur over the life of the plan would have more than a negligible effect on soil conditions. Assuming the average spill would cover 0.1 acre, under Alternative B-1 approximately 4 acres would be impacted substantially during the lifetime of development in the NPR-A. This is about 26 percent less than the acreage impacted under Alternative A. Overall, past spills on Alaska's North Slope have resulted in minor ecological damage, and ecosystems have shown good potential for recovery (Jorgenson 1997).

A single gas release occurring with ignition could have thermal effects to approximately 194 acres of tundra soils (500-meter radius). The assumed number of gas releases under Alternative B-1 (2.4 = 792 miles at a rate of 0.9 incidents per 300 pipe miles), if ignited, would result in thermal effects to approximately 504 acres. If a wildfire resulted, additional acreage would burn, the amount depending on season, weather conditions, moisture content of organic layers, and suppression effort. Of the 22 instances of North Slope tundra fires between 1955 and 2007, most were less than 1,000 acres (Racine and Jandt 2008). Total vascular plant cover of bare soils following lightning-caused tundra fires reached 50–100 percent after 5 to 6 years (Racine et al. 1987). High-intensity fire may destroy both soil structure and soil organic matter, which would require pedogenesis to restart with invasion by lichens. Lichens, however, could take several decades to recover if they can achieve former densities at all under a climate-warming regime (Jandt et al. 2008).

Commercial Gas Development

The types of impacts on soils that natural gas development and production would cause under Alternative B-1 would be the same as those caused by oil development described above, except that there would be no crude-oil spills. Because the length of buried gas pipeline and the single standalone compressor station would be the same as projected for Alternative A, it is anticipated that gas development would cause similar impacts as Alternative A.

4.4.3.3 Effectiveness of Stipulations and Best Management Practices

To protect soils in the planning area, the approval of most proposals for summer operations are limited. Because of the fragile nature of thawed tundra during the summer, permit sites are restricted to durable areas such as gravel bars, beaches, or existing gravel pads. Vehicles allowed for use in overland moves would exert low ground pressure and be permitted to travel only over snow-covered ground frozen to a sufficient depth to minimize soil and vegetation impacts. Many of the lease stipulations and best management practices under Alternative B-1 directly or indirectly limit potential impacts to soils in the planning area. Lease stipulations and best management practices developed to protect soil under

Alternative B-1 would provide similar protection to soil resources as the stipulations developed for Alternative A.

Many of the lease stipulations and best management practices under Alternative B-1 would directly or indirectly limit potential impacts to soils in the planning area. Best Management Practices A-1 through A-7 relate to waste prevention, handling, disposal, spills, and public safety. These best management practices would be effective in ensuring that waste materials associated with exploration and development activities were properly disposed of, and helping to prevent impacts to soils from spills and mishandling of materials. They would also provide for rapid cleanup of spills, which would decrease the likelihood of impacts to soils from spills. Best Management Practices A-9 and A-10 would reduce air pollution. Best Management Practice C-2 on overland moves and seismic work would also effectively minimize impacts to the vegetative layer that protects the soil.

Lease Stipulation D-1 would effectively protect riparian habitat by preventing exploratory drilling in rivers, streams, and active floodplains. Lease Stipulation D-2 would effectively minimize surface impacts from exploratory drilling by limiting activities to temporary structures such as ice pads, ice roads, ice airstrips, and temporary platforms, unless permanent structures were absolutely required. Lease Stipulation E-2 and Best Management Practices E-4, E-5, E-6, E-8, and E-12 would effectively minimize impacts to soils by providing facility design and construction regulations that would limit the footprint of developments, provide protection from oil spills, provide setbacks that protect riparian and other high value habitats, and ensure that habitat and resource issues were considered in the placement of facilities. Lease Stipulation G-1 would facilitate the retention of soil properties to encourage rapid regrowth following facility abandonment The setbacks outlined in lease stipulations (K-1, K-2, K-3, K-7 and K-8) and Best Management Practice K-4 associated with development near rivers, lakes and other specified habitats would be effective at minimizing impacts in high-value wetlands and other high-potential soils, such as areas dominated by pendant grass and riparian and floodplain habitats. Best Management Practice L-1 would minimize the impacts to soils of summer tundra travel, if such an action is permitted.

Under Alternative B-1, development would result in less impact to soil and plant communities than under Alternative A. The best management practices and lease stipulations associated with Alternative B-1 are quite similar to those of Alternative A, and would provide protection to limit impacts by minimizing destruction of soil profiles and alteration of plant communities.

4.4.3.4 Conclusion

Under Alternative B-1, the amount of soil area impacted from oil and gas exploration and development would potentially be less than those of Alternative A as fewer high-potential oil and gas areas would be available for leasing. Numerous technological advancements during the decades of operations on the North Slope have allowed current development activities to proceed with less environmental impact than previous operations (National Research Council 2003). However, some short-term disturbance and permanent long-term impacts to soils are inevitable. Impacts to soil resources from Alternative B-1 would potentially be somewhat lower than Alternative A, as fewer high-potential oil and gas areas would be available for leasing. See Table 4-14 for a comparison of estimated total surface area disturbed by alternative. Loss of permafrost and soil insulation from activities associated with this alternative could be exacerbated by climate change as described in the conclusion of Alternative A.

Impacts to soil from management actions under Alternative B-1 would involve short-term disturbance over fairly large areas and long-term disturbance of relatively small areas. However, since impacts in Alternative B-1 cover less of the planning area than any other alternative (see Table 4-14), the area of soil disturbance would be relatively small as a percentage of the entire planning area (see below). The duration of these impacts could range from one year or less, for minor disturbance of soil and vegetation, to decades, if the soil was destroyed or permafrost thawing was extensive.

Impacts to soils from activities other than oil and gas development under all alternatives would include minor impacts from aircraft landings, archaeological or paleontological excavations, camps, and overland moves. Recovery would vary from one year, for minor disturbance of soil and vegetation, to decades in those areas where soil was excavated or permafrost thawing was extensive.

Impacts to soils from oil and gas exploration under Alternative B-1 would occur from seismic work and construction of well cellars during exploratory drilling and the construction of ice roads and ice pads. The duration and recovery time for impacts associated with seismic work would be similar to those for overland moves and the same as for Alternative A. Based on earlier studies, there should be no substantial, long-term impacts to soils from seismic lines, but substantial impacts from camp move trails could remain on approximately 1,670 acres after 8 to 9 years. Effects of well cellar construction would also be permanent, but would impact only 0.2 acre of soil.

The effects of oil and gas development and operation would include destruction of soils during construction of gravel pads (central processing facilities and central gas facilities, satellite drill pads, pump and compressor stations, and staging bases), roads and airstrips; from excavation of material sites and burial of gas pipelines; and construction of vertical support members. These impacts would be long-term and would impact about 7,505 acres, or 0.03 percent of the 22.8 million-acre NPR-A (as compared to 0.04 percent under Alternative A). Soil profiles could also be altered by dust deposition, salinity of gravel fill used in construction, snowdrifts, and blockage of or change to natural drainage patterns. These impacts would also be long-term and would impact about 20,737 acres, or 0.09 percent of the NPR-A (30 percent less than the amount of soil impacted under Alternative A).

It is assumed that impacts to soils and their vegetative communities would occur in proportion to their occurrence within the NPR-A. However, prohibiting development in a broad area around Teshekpuk Lake under Alternatives B-1 and B-2 could disproportionately conserve wetland soil classes compared to Alternative A. A higher percentage of wet soil groups occur in the area around the lake. Alternatively, precluding development in a large block in the south and west of the NPR-A would disproportionately conserve gravelly soils and their vegetative communities. This latter effect would be essentially the same, but larger under Alternative A.

Areal extent of short-term impacts under Alternative B-1 would be about 28 percent less than for Alternative A and 7 percent less than Alternative B-2. Areal extent of long-term impacts under Alternative B-1 would be about 24 percent less than for Alternative A and 11 percent more than for Alternative B-2. Impacts to soils from non-oil and gas activities, and from oil and gas activities, would likely be additive, except in those areas where the two types of activities overlapped. Impacts to soils from exploration and development activities would also be additive, except where development activities occurred in areas previously disturbed during exploration. In areas where two or more activities occurred, overall impacts would reflect those impacts associated with the first activity and any new impacts associated with later activities.

4.4.4 Surface and Groundwater Resources and Water Quality

Alternative B-1 emphasizes the protection of surface resources, while making nearly 11 million acres of federally owned subsurface (48 percent of the total in NPR-A) available for oil and gas leasing. It would provide for a corridor to bring oil and gas from potential future offshore development in the Chukchi Sea to market via Umiat and to Alpine or Kuparuk. Section 2.3.2 describes this alternative in greater detail. This compares to Alternatives A, B-2, C, and D, which, respectively, offer 57, 52, 76, and 100 percent to leasing. Based on the potential for leasing, Alternative B-1 would have the least potential for impacts to water resources and quality from exploration and development. Many of the required operating procedures in Alternative A are now referred to as best management practices in Alternatives B-1, B-2, C, and D, using the same numbering scheme with very similar language.

4.4.4.1 Activities Not Associated With Oil and Gas Exploration and Development

Under Alternative B-1, impacts to water resources and quality associated with non-oil and gas activities would essentially be the same as those described under Alternative A, section 4.3.4.1.

4.4.4.2 Activities Associated With Oil and Gas Exploration and Development

Effect of Seismic Surveys

Modern-day seismic equipment has caused minimal impact to the tundra, but camp move vehicles can still cause thermokarst, especially when snow is insufficient to protect soil and vegetation (WesternGeco 2003). Removal or damage of the organic mat exposes soils to erosion by wind and water, which could deposit sediment into waterbodies resulting in higher turbidity and concentrations of suspended sediment. To cause high turbidity, the peat mat must be sufficiently eroded to expose underlying mineral soils, and the mineral soils must be fine grained. Best Management Practice C-2 requires ground operations to commence only when frost and snow are at sufficient depths to protect stream banks, and minimize the breakage, abrasion, compaction, or displacement of vegetation and prevent future thermokarst.

Studies of impacts to vegetation from seismic activity are discussed in section 4.3.5.2. It is estimated that a total of 1,670 acres of moderate to high impacts from seismic activities could result from Alternatives B-1 and B-2, slightly more than Alternative A, and less than Alternatives C and D. These long-term impacts may result in thermokarst erosion with increased turbidity in local waterbodies.

Effects of Water Withdrawal from Lakes

The primary source of water during the winter months is unfrozen water that lies beneath the ice cover of both shallow and deep lakes. This water is somewhat saline because of the exclusion of ions during the freezing of the upper part of the lake. Water from lakes may be used for ice roads, pads and airstrips; and for drilling and production water and potable water at drilling facilities; but the volume of water taken from an individual lake depends on the depth of the lake, depth of unfrozen water in the lake, and the presence of fish and the type of fish present.

Alternative B-1, with the least amount of leased land, will have fewer exploratory wells drilled; therefore, less water would be required for production, and fewer areas would be impacted. Best Management Practice B-2 insures water-permitting requirements are followed and are supplemented by water monitoring plans as needed to insure lakes are replenished. Effects during exploration on water quality from water withdrawals would be short term and minor, returning to normal levels after breakup. The provisions under Alternative B-1 are adequate to insure water quality and quantity is maintained after water withdrawals.

Effects of Ice Roads, Ice Pads, and Ice Bridges

Ice roads and ice pads are used extensively during the winter exploration season for access and for exploration drilling and testing. Best Management Practice C-3 requires river crossings to be made at low angles if at all possible, and remove, breach, or slot ice bridges before breakup. Ice roads may be required to be breached at stream crossings, especially if fish passage is a concern or the quantity of expected flow is significant during breakup. Under all of the alternatives, no long-term impacts are anticipated from ice roads, ice pads, or ice bridges.

Effects of Exploratory Drilling

Drilling operations require large amounts of water to create drilling fluid, which must be disposed of at the completion of drilling operations. Drilling fluid is typically a preparation of water, clay, and chemicals circulated into a well during drilling, and must be disposed of when operations cease. Best Management Practice A-2 requires all cuttings and drilling mud to be disposed of by injection, allowing on-pad temporary storage of muds and cuttings, as approved by Alaska Department of Environmental Conservation. Freshwater aquifers are protected by surface casing that is installed and cemented in place at varying depths, which are determined, by State natural gas and oil regulatory agencies. Lease Stipulation D-1 prohibits exploratory drilling in rivers and streams, as determined by the active floodplain, and fish-bearing lakes unless there is no feasible or prudent alternative. These protective measures will decrease the risk of drilling muds or oil from blowouts from entering adjacent waterbodies.

Under Alternative B-1 up to 128 oil and gas exploration and delineation wells may be drilled. Under Alternatives A, B-2, C, and D, 196, 152, 244, and 256 wells, respectively, may be drilled. The number of rigs estimated under Alternative B-1 should result in fewer impacts from exploratory drilling than the other alternatives. Exploratory drilling under Alternative B-1 is also not expected to have a measurable effect on water quality because spills will occur in the winter and will likely occur on ice pads.

Effects of Drainage Disruption by Gravel Roads, Pads, Runways, and Pipelines

Placement and construction of gravel pads, roadways, pipelines, bridges, runways, and culverts have the potential to divert, impede, or block flow in stream channels or shallow-water tracks, disrupting natural drainages. This disruption of streambeds and stream banks can remove protective shoreline vegetation and lead to channel erosion and sedimentation, formation of meltwater gullies, and formation of alluvial fans in streams and lakes (Lawson 1986).

Stream crossing structures can create scour channels and channel bars in streams and cause erosion from the pads or roads and transport gravel into streams and lakes. Blockages in areas with low flow capacity, especially culverts blocked by snow and ice, can result in seasonal and sometimes permanent impoundments (National Research Council 2003). The resulting inundation can affect tundra vegetation and possibly lead to thermokarst or creation of deeper, open waterbodies (Walker et al. 1987a, 1987b). Potential drainage pattern disruptions would be proportional to the acres of gravel and number of stream-crossing structures installed with each alternative.

Pipeline construction within the NPR-A would depend on the location and sequence of commercial-size discoveries. Narrow streams could be crossed using elevated pipelines on suspension spans. Wider, shallow rivers could be crossed by trenching and burying insulated pipelines in the riverbed. All entrenched crossings would be constructed in the winter at locations selected to minimize disturbances to tundra. All pipelines would be routed to avoid lakes.

Once installed, suspended and entrenched pipelines would have no effect on stream and water flow characteristics. Buried pipelines, which are less commonly used on the North Slope, could have potential thermokarst, subsidence, and possible exposure by stream erosion beyond the construction phase.

Impacts from drainage disruptions will be mitigated by Lease Stipulation E-2 which prohibits permanent oil and gas facilities within specified distances from waterbodies, Best Management Practice E-6 that requires that stream and marsh crossings be designed and constructed to ensure free passage of fish, reduce erosion, maintain natural drainage, and minimize adverse effects to natural stream flow and Lease stipulations K-1 (Rivers) and K-2 (Deep Water Lakes) which require setbacks from rivers and lakes for permanent oil and gas facilities to minimize the disruption of natural functions resulting from the loss or change to vegetative and physical characteristics of deep water lakes.

Because more or less infrastructure is estimated to occur in different alternatives, the potential for some shortcoming in design of infrastructure to result in impacts will vary with that variation among the alternatives. The stipulations and design requirements described above should provide adequate protection to ensure natural flow characteristics and water quality is maintained.

Under Alternative B-1 the BLM estimated 5,037 acres of gravel placement for production pads, in-field roads and runways. This compares to Alternatives A, B-2, C, and D with 7,074, 5,614, 9,387, and 10,438 acres, respectively. Alternative B-1, with the least area available for leasing, would have less disruption of drainages, erosion, and sedimentation than under the other alternatives. However, if the lease stipulations and best management practices listed for this alternative are followed, impacts should be minor.

Effects of Gravel Pits

Removal of gravel from areas near streams and lakes can result in changes to stream or lake configurations, stream-flow hydraulics, lake shoreline flow patterns, erosion, sedimentation, and ice damming (National Research Council 2003). Locating gravel pits at an adequate distance from streams and lakes would minimize these impacts. Alternative sources of gravel for future development might include importing gravel from borrow sites east of the Colville River, extracting gravel from existing sites, processing bedrock, or using sand/silt/foam composites.

Gravel mining in the coastal plain would create some localized sedimentation and new or enlarged waterbodies, particularly if gravel was extracted from within floodplains. Gravel extraction outside the floodplain, especially within the foothills, would be less likely to create new lakes, but could produce sedimentation. Best Management Practice E-8 would locate gravel mine sites outside active floodplains whenever possible.

Alternative B-1, since it would remove a large part of the coastal plain from leasing and development, would likely result in fewer new lakes from gravel mining than the other alternatives. Under Alternative B-1, up to 29 gravel pits (1,007 acres) could be required for the development scenarios presented in Table 4-14. This compares to 40 (1,415 acres), 31 (1,125 acres), 51 (1,868 acres), and 55 (2,088 acres) gravel pits, respectively, for Alternatives A, B-2, C, and D.

Effects from Waterflooding

Waterflooding is a process of injecting water into underground reservoir rock to maintain reservoir pressure and maximize recoverable oil reserves. Alaska Oil and Gas Conservation Commission oversees the Underground Injection Control Program to ensure underground sources of drinking water are protected. Under Alternative B-1 an estimated 404 oil production and service wells and 220 gas production and water disposal wells could be drilled, the lowest of all the alternatives. Therefore, spills or groundwater contamination impacts from waterflooding will be less likely to occur under Alternative B-1 than any other alternative. Impacts to groundwater resources or from spills transporting seawater to wells for waterflooding are expected to be minimal.

Effects of Oil Spills and Gas Releases

Under Alternative B-1, the types of impacts to water resources and quality associated with oil spills and gas releases would essentially be the same as those described under Alternative A, section 4.3.4.2.

There are a number of stipulations and best management practices that would help reduce the risk of fuel-related spills. BMP A-3 requires a Hazardous Materials Emergency Contingency Plan before transportation, storage, or use of fuel or hazardous substances contingency plans require industry to provide refresher spill-response training, and plan and conduct a major spill-response drill annually. BMP A-4 mandates that lessees are required to develop a comprehensive spill prevention and response contingency plan, which will have sufficient on-site oil-spill-cleanup materials and proper storage containers.

BMP A-5 places restrictions on refueling or storage of equipment within the active flood plain of any water body. Lease Stipulation E-2 prohibits permanent oil and gas facilities, including roads, airstrips, and pipelines, within 500 feet of the ordinary high water mark. Essential pipeline and road crossings will be permitted on a case-by-case basis and construction camps are prohibited on frozen lakes and river ice. BMP E-4 requires all pipelines to be designed, constructed, and operated under an authorized officer-approved quality assurance/quality control plan specific to the product transported.

Under Alternative B-1, the BLM estimates there could be 367 small spills of refined and crude oil less than 500 barrels in size. This compares to estimates of 525, 399, 514, and 553 spills, respectively, from Alternatives A, B-2, C, and D. Alternative B-1 predicts a 28 percent chance of one or more large oil spills greater than 500 barrels and a 43 percent chance of one or more large spills greater than 500 barrels of produced water or seawater, which are the greatest potential for spills than all other alternatives.

Effects of Abandonment and Reclamation

Removal of facilities, particularly roads, bridges, and culverts, would likely cause increased sedimentation and erosion immediately after removal. However, natural drainage will be reestablished within several years to more than a decade depending upon the facilities removed and the local hydrology and terrain. Leaving pads, airstrips, roads, bridges, and culverts in place, particularly without future maintenance, however, would result in longer-term, higher levels of erosion, sedimentation, and upslope impoundment. Ponds would be formed from melting of ice wedges or other ice underlying the gravel facilities. Leaving the roads in place, but removing bridges and culverts and breaching the roads where culverts had been placed, would reduce upslope impoundment. Because under Alternative B-1 less gravel infrastructure would be created than under any other alternative, Alternative B-1 could result in less sedimentation, erosion, and water impoundment than all other alternatives due to the reduced amounts of infrastructure.

4.4.4.3 Effectiveness of Lease Stipulations and Best Management Practices

These are a summary of BMPs and lease stipulations already discussed in the sections above which are protective of water resources and water quality.

BMPs A-1 through A-7 would regulate garbage, wastewater, drilling wastes, fuel and chemical storage, fuel handling, and require spill prevention and clean-up plans. These BMPs would be effective in ensuring that waste materials associated with exploration and development activities were properly disposed of and help prevent impacts to water resources from spills and mishandling of materials. BMP B-1 and 2 would prohibit water withdrawals from rivers during winter to protect over-wintering fish and regulate lake water withdrawals based on volume, depth, fish populations, and species diversification. BMP C-2 requires ground operations to commence only when frost and snow are at sufficient depths to protect stream banks, minimize the breakage, abrasion, compaction, or displacement of vegetation and preventing future thermokarst. BMP C-3 requires crossings of waterway courses to be made using a low-angle approach, and that any reinforced crossings with additional snow or ice be removed before breakup. This requirement maintains natural spring runoff patterns, avoids flooding, minimizes streambed sedimentation and ensures water quality is maintained. BMP C-4 prohibits travel up and down streambeds unless it can be demonstrated that there will be no impacts from such travel to over-wintering fish. Crossings of rivers and streams will be made at shallow riffles from point bar to point bar whenever possible. BMP E-6 requires that stream and marsh crossings be designed and constructed to ensure free passage of fish, reduce erosion, maintain natural drainage, and minimize adverse effects to natural stream flow. BMP E-8 requires that gravel mine sites be located outside the active flood plain whenever possible, or serve as water reservoirs when located within flood plains. BMP L-1 would protect stream banks and water quality by requiring low-ground-pressure vehicles to be used only on a case-by-case basis when studies have demonstrated that their use would only result in minimal impacts to soil and vegetation.

Lease Stipulation D-1 prohibits exploratory drilling in rivers and streams, as determined by the active floodplain, and fish-bearing lakes. This protects fish-bearing rivers, streams, and lakes from spills and minimizes alteration of riparian habitat with potential resultant sedimentation and erosion. Lease Stipulation E-2 prohibits permanent oil and gas facilities, with some limited exceptions, within specified distances from waterbodies. Construction camps are prohibited on frozen lakes and river ice. This stipulation protects fish-bearing waterbodies, water quality, and aquatic habitats. Lease Stipulation G-1 could require removal and reclamation of the developed site(s) upon field abandonment, which would eventually result in restoration of the natural drainage. Lease stipulations K-1 (Rivers) and K-2 (Deep Water Lakes) require setbacks from rivers and lakes for permanent oil and gas facilities to minimize the disruption of natural functions resulting from the loss or change to vegetative and physical characteristics of deep water lakes.

4.4.4.4 Conclusion

The potential impacts to water resources and quality from oil exploration and development activities under Alternative B-1 include the following: turbidity changes of waterbodies due to thermokarst from seismic and overland travel activities and from dust effects adjacent to roads and pads; losses of water and possible water quality changes from water withdrawals; erosion and sedimentation associated with road and pad building; inadequately designed river crossing structures; impounded water at road crossings; alteration of drainages from pipelines, pads, ice and gravel roadways, airstrips, and gravel mines; and impacts on water quality from oil, produced water and seawater spills into waterbodies.

Global climate change could have unpredictable impacts on winter temperatures, water balance and availability of water, timing and magnitude of spring floods, rising sea level, storm surges, and coastal erosion. A shortened winter season and warmer soil temperatures could increase the potential to damage vegetation from seismic surveys and overland travel and result in thermokarst. A longer growing season could result in increased potential evapotranspiration reducing available water in lakes. Premature melting of ice roads could occur with sudden spring melts, requiring emergency demobilization of drilling operations in order to protect the tundra. Increased snowfall combined with late summer rainfall could increase the magnitude of spring peak flows above the normal range of flows. Greater expanses of open water on the Beaufort and Chukchi seas could increase the potential for storm surges to cause accelerating rates of coastal erosion and flooding of inland lakes and ponds. All alternatives under consideration would be affected, although fewer impacts under Alternative B-1 would occur due to less development in the Teshekpuk Lake area.

Adherence to federal and State operational guidelines, best management and safety practices, planning requirements, lease stipulations and BMPs will all serve to reduce impacts from these activities. Some localized, but temporary effects to water resources or quality may occur from most activities described in Alternative B-1. The exception would be the case for permanent gravel pads and stream crossing structures and very large spills, which would have long-term impacts described in the above sections.

In general, impacts between alternatives are proportional to acres available to leasing and projected future production. Alternative B-1 would be expected to have fewer impacts to water resources and quality than all other alternatives.

4.4.5 Vegetation

4.4.5.1 Activities Not Associated with Oil and Gas Exploration and Development

Under Alternative B-1, impacts to vegetation associated with non-oil and gas activities would essentially be the same as those described under Alternative A.

4.4.5.2 Oil and Gas Exploration and Development Activities

Various activities associated with oil and gas exploration, development, and production could impact vegetation in the NPR-A. These activities include seismic operations; exploration drilling; gravel road, pad, and airstrip construction; pipeline construction; and construction of ice roads and ice pads.

Exploration

Under Alternative B-1, types of impacts to vegetation from activities associated with oil and gas exploration would be similar to those that occur under Alternative A, except that there would be fewer exploration and delineation wells drilled, which would decrease the impacts of well collar construction and the number and impacts of both ice pads and ice roads.

Under Alternative B-1, the same scenario for seismic exploration is assumed as for Alternative A in terms of number and types of surveys, the area covered is slightly larger for the 3-D surveys. Short-term vegetation disturbance from 2-D and 3-D operations combined would total a maximum of 581,397 acres (2.5 percent of the 22.8-million-acre NPR-A). Long-term disturbance is estimated to total 1,670 acres.

During the life of the plan, it is assumed that 64 exploration wells and the same number of delineation wells, or a total of 128 wells for both oil and gas, would be drilled from ice pads in the NPR-A under Alternative B-1. At 6 acres per pad, these would impact 768 acres of tundra, spread out over 30 years (a reduction of 35 percent compared to Alternative A).

Under Alternative B-1, ice road and snow trail construction would also be less than in Alternative A in terms of total miles. The total acreage of short-term disturbance from ice roads and snow trails over 30 years would be 231,995 acres, about 28 percent less than for

Alternative A. Since vegetation recovery from ice road impacts is expected within a few years (Yokel et al. 2007), long-term disturbance from ice roads would be negligible. Although some evidence of crushed tussocks may still be apparent, new growth would preclude any exposed soils.

Ice airstrips are also used during exploratory drilling, and under Alternative B-1, it is assumed that 65 ice airstrips would be constructed, covering 11 acres each for a total of 715 acres (35 percent less than under Alternative A). These airstrips are commonly built on the grounded ice of large lakes, but if they were built over tundra they would result in impacts similar to ice roads.

The construction of well cellars during exploration requires digging a hole that destroys vegetation on approximately 64 square feet (0.0015 acre) of ground. Thermokarst associated with the disruption of thermal regime in the surrounding soil may also change the vegetation type around the well cellar to a wetter vegetation type. These impacts could result in 0.2 acres of vegetation being destroyed under Alternative B-1 (33 percent less than under Alternative A).

Development

During oil and gas development and production, various activities could cause impacts to vegetation in the NPR-A. These activities include construction and use of gravel pads, roads, airstrips, and pipelines, excavation of material sites, and construction of ice roads and ice pads. Ice roads and pads are covered above.

Placement of Gravel Fill

Construction of central processing facilities or gas compressor facilities and associated satellite pads, roads, staging areas, and airstrips would result in the destruction of vegetation in the areas of gravel placement. Under this alternative, nine central processing facilities and 19 gas compressor facilities with associated satellite pads, roads and airstrips, two pump stations and three staging bases would be developed, resulting in 4,872 acres of vegetation being destroyed by gravel placement (35 percent less than under Alternative A).

The decreased facilities construction and use under Alternative B-1 would result in a smaller area impacted by dust than under Alternative A. Assuming a total of 496 miles of in-field gravel roads and 25.6 miles of airstrips, there is a potential for a total perimeter of 1,043 miles. Within 30 feet of gravel fill, up to 3,793 acres of vegetation could be subject to smothering by dust and gravel, and another 15,171 acres could be affected by a dust shadow that affects out to 150 feet.

Construction of gravel pads, roads, and airstrips could alter the moisture regime of tundra near the structure by changing natural drainage patterns and areas where snow accumulates. Snowdrifts caused by gravel structures increase the wintertime soil surface temperature and increase thaw depth in soils near the structures. These impacts are exacerbated by dust deposition (described above) and by the formation of impoundments (described below). These factors could combine to warm the soil, deepen thaw, and produce thermokarst adjacent to roads and other gravel structures (NRC 2003). Additionally, these changes could alter the species composition of the plant community near gravel structures. In general, most changes in the plant community around gravel structures would occur within 164 feet of the structure. If all effects were to occur within this zone, a maximum of 20,734 acres would be impacted under Alternative B-1 (29 percent less than under Alternative A). Note that this area includes the 18,964 acres affected by dust above, and is not in addition to it.

The construction of gravel roads into and within the NPR-A would provide a mechanism for the spread of non-native, invasive plants into the NPR-A. The effects of dust and gravel spray from the roads may also provide a substrate suitable for colonization of non-native, invasive plants. Oil and gas development in the NPR-A may cause, or accelerate, the invasion of the NPR-A by non-native, invasive plants. The potential for colonization by non-native, invasive plants could be reduced by pressure washing all equipment and vehicles before moving them into the NPR-A. This could effectively remove any seeds that wedge in cracks or crevices, or adhere to equipment or vehicles. Removing dirt from vehicles could also prevent potentially dangerous soil-borne pathogens or contaminants from being introduced to the NPR-A.

Material Sites

Gravel required for development in the NPR-A could be mined from existing sites east of the NPR-A, or could be extracted from new sites developed within the NPR-A. Investigations to identify gravel sources in the NPR-A have not been conducted, for undiscovered oil and gas, although the Clover Mine Site west of Nuiqsut was identified for discovered oil during exploratory drilling and was subsequently further assessed. Additional surveys for gravel resources will presumably be initiated if further discoveries of recoverable oil and gas are made. Under Alternative B-1, it is assumed that up to 29 material sites would be needed, covering a total area of 1,007 acres (29 percent less than under Alternative A). Excavation of the gravel mine and stockpiling of overburden would destroy vegetation at these sites.

Pipelines

Under Alternative B-1, types of impacts from oil and gas pipeline construction would be similar to those described for Alternative A. The total area disturbed by each vertical support member for oil pipelines would be about 15 square feet. About 6 percent of this area would be vegetation destroyed and replaced by the vertical support member, and the remaining portion would be potentially altered in terms of community type or species composition. Approximately 0.05 acre of vegetation would be disturbed per pipeline mile for oil-gathering pipelines, and 0.03 acre per mile of regional oil pipelines. Under Alternative B-1, 154 miles of gathering lines for oil, and 451 miles of regional oil pipelines would disturb about 20 acres of vegetation through vertical support member placement, or about 26 percent less than under Alternative A. Ice roads built for constructing these pipelines would have short-term impacts to vegetation on less than 2,565 acres. In reality, some of the vertical support members for gathering lines would be over gravel pads and would have no impacts on vegetation, nor would ice roads be necessary for constructing these portions of pipeline. It is assumed that gas pipelines would be buried, so impacts to vegetation would be different than for oil pipelines. In the case of buried gathering, regional, and high-pressure gas pipelines, short-term disturbance from ice roads would affect 3,360 acres. Long-term impacts from trenching and spoils storage would occur on 1,440 acres.

Summer Tundra Travel

On a case-by-case basis, the BLM may permit low-ground-pressure vehicles to travel off gravel pads and roads during periods other than when the ground is frozen and covered with snow. This is expected to be an uncommon occurrence, and if permitted at all it would likely be only during early summer or late summer to fall. Because of restrictions that would be placed on this activity, impacts to vegetation should be limited to the compression of standing vegetation, similar to what happens during winter following traffic by low-ground-pressure vehicles.

Air Pollution

The potential for impacts to vegetation from air pollution would be less under Alternative B-1, given the smaller scenario for additional oil and gas fields and processing and compressor facilities, as compared to Alternative A.

Abandonment and Reclamation

During abandonment activities, vegetation and wetlands would be impacted by dust fallout along roads, by ice roads and other off-road tundra travel associated with dismantling of pipelines and power lines, and by disturbance to vegetation adjacent to vertical support members and power line poles during their removal. The level of impact from these activities would be roughly the same as that during construction if gravel fill was removed; impacts would be less if the gravel were left in place. If roads and pads were left in place, and especially if cross drainage across roads was not maintained, water impoundment would occur, and could alter plant communities as described for the construction period. It is also likely that the unmaintained roads would have occasional washouts, where tundra vegetation would be covered with washed-out gravel. Roads and pads, if left in place, would likely need to be revegetated with plants native to gravel bars and ridges in the Arctic (i.e., different from the plant communities surrounding the facilities). Revegetation activities could take several years, as initial attempts are not always successful. Removal of gravel from pads, roads, and airstrips could be mandated. Partial or complete removal of gravel can result in faster reestablishment of native plant growth, although establishment can take many years (more than a decade). In addition, thaw subsidence is difficult to predict, and complete restoration to preexisting conditions is not likely.

Effects of Spills and Gas Releases

The reduced amount of leasing, development, and production of oil and gas that would occur under Alternative B-1, relative to Alternative A, would result in a smaller number of small spills of crude and refined oil, produced water, and seawater in the NPR-A, but a larger number of gas releases due to the increased miles of regional gas pipelines assumed. The probability of a large oil spill occurring would also be less under Alternative B-1; but for analysis, the assumption remains at one large spill.

Most oil spills cover less than 500 square feet (less than 0.01 acre), although a pressured aerial mist may cover up to 145 acres (Ott 1997). (Such a spill is a very low probability event, occurring less than once out of the total spills expected throughout the life of this plan. Thus, its magnitude is not apparent in the following acreages.) If 11 percent of all oil spills would reach vegetation during summer, under Alternative B-1 this would mean 40 of the 368 crude and refined oil spills assumed to occur over the life of the plan would have more than a negligible effect on vegetation. Assuming the average spill would cover 0.1 acre, under Alternative B-1 approximately 4 acres would be impacted substantially during the lifetime of development in the NPR-A. This is about 33 percent less than the acreage impacted under Alternative A. Overall, past spills on Alaska's North Slope have resulted in minor ecological damage and ecosystems have shown good potential for recovery (Jorgenson 1997). There are techniques that may accelerate the cleanup process after an oil spill (e.g., Yakubu et al. 2009).

A single gas release occurring with ignition could have thermal effects to approximately 194 acres of tundra vegetation (500-meter radius). The assumed number of gas releases under Alternative B-1 (2.6 = 0.9 incidents per 300 pipe miles times 857 miles of pipe), if ignited, would result in thermal effects to approximately 504 acres of tundra. If a wildfire resulted, additional acreage would burn, the amount depending on season, weather conditions, moisture content of vegetation, and suppression effort. Most North Slope tundra fires are less than 1,000 acres (Racine and Jandt 2008). Total vascular plant cover following lightning-caused tundra fires reached 50–100 percent after 5 to 6 years (Racine et al. 1987). Lichens, however, could take several decades to recover, if they can achieve former densities at all under a climate-warming regime (Jandt et al. 2008).

4.4.5.3 Effectiveness of Stipulations and Best Management Practices

Many of the lease stipulations and best management practices associated with Alternative B-1 would directly or indirectly limit potential impacts to vegetation in the NPR-A. Best Management Practices A-1 through A-7 relate to waste prevention, handling, disposal, spills, and public safety. They ensure that waste materials associated with exploration and development activities would be properly disposed of and would effectively minimize impacts to vegetation from spills and mishandling of materials. They would also provide for rapid cleanup of spills, decreasing the likelihood of impacts to vegetation. Best Management Practices A-9 and A-10 would reduce air pollution. Best Management Practice C-2 on overland moves and seismic work would also effectively minimize impacts to vegetation.

Lease Stipulation D-1 would effectively protect riparian habitat by preventing exploratory drilling in rivers, streams, and active floodplains. Lease Stipulation D-2 would effectively minimize surface impacts from exploratory drilling by limiting activities to temporary structures such as ice pads, ice roads, ice airstrips, and temporary platforms unless permanent structures were absolutely required. Lease Stipulation E-2 and Best Management Practices E-4, E-5, E-6, E-8, and E-12 would effectively minimize impacts to vegetation by providing facility design and construction regulations that would limit the footprint of developments, provide protection from oil spills, provide setbacks that protect riparian and other high-value habitats, and ensure that habitat and resource issues were considered in the placement of facilities. Lease Stipulation G-1 would facilitate the regrowth of native vegetation following facility abandonment. The setbacks outlined in lease stipulations (K-1, K-2, K-3, K-7 and K-8) and Best Management Practice K-4 associated with development near rivers, lakes, and other specified habitats would be effective at minimizing impacts in high-value wetlands, such as areas dominated by pendant grass and riparian and floodplain habitats. Best Management Practice L-1 would minimize the impacts to vegetation of summer tundra travel, if such an action is permitted.

Under Alternative B-1, development would result in fewer impacts to vegetation and plant communities than under the other alternatives. The best management practices and lease stipulations associated with Alternative B-1 are quite similar to those of Alternative A and would provide protections to limit impacts by minimizing destruction of vegetation and alteration of plant communities.

4.4.5.4 Conclusion

Under Alternative B-1, impacts to vegetation from activities other than oil and gas development would be essentially the same as those under Alternative A, and would include minor impacts from aircraft landings, archaeological or paleontological excavations, camps, and overland moves. The duration of the actions causing these impacts would be short-term, ranging up to five months, and recovery would vary from one to several years. Some impacts from snow machines and ATVs, where the same trail is followed continuously such as near villages, could be major (but localized) and would not recover as long as the traffic continues.

As for Alternative A, impacts to vegetation from oil and gas exploration under Alternative B-1 would occur from seismic work and construction of well cellars during exploratory drilling and the construction of ice roads and ice pads. The duration and recovery time for impacts associated with seismic work would be similar to those for overland moves and the same as for Alternative A. Based on earlier studies, there should be no substantial, long-term impacts to vegetation from seismic lines, but substantial impacts from camp move trails could remain on approximately 1,670 acres after 8 to 9 years. Effects of well cellar construction would also be permanent, but would impact only 0.2 acre of vegetation.

The effects of oil and gas development and operation would include destruction of vegetation during construction of gravel pads (central processing facilities and gas compressor facilities, satellite drill pads, pump stations, and staging bases), roads and airstrips; from excavation of material sites and burial of gas pipelines; construction of vertical support members; and the potential for colonization by non-native, invasive species. These impacts would be long-term and would impact about 7,505 acres, or 0.03 percent of the 22.8-million-acre NPR-A (as compared to 0.04 percent under Alternative A). Plant communities could also be altered by dust deposition, salinity of gravel fill used in construction, snowdrifts, and blockage of or change to natural drainage patterns. These impacts would also be long-term and would impact about 20,734 acres, or 0.09 percent of the NPR-A (29 percent less than the amount of vegetation impacted under Alternative A).

It is assumed that impacts to vegetation types or communities would occur in proportion to their occurrence within the NPR-A. However, prohibiting development in a broad area around Teshekpuk Lake under Alternative B-1 could disproportionately conserve wetland vegetation classes compared to Alternative A. A higher percentage of wet vegetation communities occur in that area around the lake. Alternatively, precluding development in a large block in the south and west of NPR-A would disproportionately conserve dwarf shrub, tussock tundra, and sparsely vegetated communities. This latter effect would be essentially the same but larger under Alternative A.

Areal extent of short-term impacts under Alternative B-1 would be about 28 percent less than for Alternative A. Areal extent of long-term-term impacts under Alternative B-1 would be about 28 percent less than for Alternative A. Impacts to vegetation from non-oil and gas activities, and from oil and gas activities, would likely be additive, as opposed to compensatory, except in those areas where the two types of activities overlapped. Impacts to vegetation from exploration and development activities would also be additive, except where development activities occurred in areas previously disturbed during exploration. In areas where two or more activities occurred, overall impacts would reflect those impacts associated with the first activity and any new impacts associated with later activities. As for Alternative A, recovery of tundra vegetation to its original composition from any of the above impacts may be delayed or precluded entirely as a result of simultaneous effects of climate change, i.e., increased shrub height and cover extent, decreased lichen and moss cover, increased thermokarst, and increased inundation of coastal areas by salt water. Such impacts of climate change could accumulate with any changes in soil thermal regimes that might occur as a result of past and future non-oil and gas and oil and gas activities in and near the NPR-A, potentially leading to synergistic impacts to vegetation.

4.4.5.5 Potential Mitigation Measure—Weed-Free Vehicles (new best management practice)

The objective and requirement or standard would be the same as those described in section 4.3.5.5. The potential benefits and residual or unavoidable impacts would be similar to those described for Alternative A at section 4.3.5.5.

4.4.6 Wetlands and Floodplains

4.4.6.1 Activities Not Associated with Oil and Gas Exploration and Development

Under Alternative B-1, impacts to wetlands and floodplains associated with non-oil and gas activities would essentially be the same as those described under Alternative A.

4.4.6.2 Oil and Gas Exploration and Development Activities

Various activities associated with oil and gas exploration, development and production could impact wetlands and floodplains in the NPR-A. These activities include overland moves, seismic operations, exploration drilling, construction of ice roads and ice pads, summer tundra travel, gravel roads, gravel pads for pump stations, central processing facilities, gas compressor facilities, and staging bases, airstrips, pipeline construction, and gravel mine sites.

Exploration

The types of impacts to wetlands and floodplains from activities associated with oil and gas exploration under Alternative B-1 would be similar to Alternative A. Alternative B-1 and Alternative A also would have the same scenarios for seismic exploration in terms of number and types of surveys However, the area covered is slightly larger in Alternative B-1 for the 3-D surveys. Short-term wetland vegetation disturbance from all seismic operations combined would total a maximum of 581,397 acres. Long-term disturbance would be approximately 1,670 acres.

The reduced exploration and delineation wells estimated to be drilled under Alternative B-1 compared to Alternative A would decrease the impacts of well cellar construction and the number and impacts of ice roads, pads, and airstrips. Under Alternative B-1, 233,478 acres of short-term disturbance may occur from ice roads, snow-packed trails, ice airstrips, and ice pads for wells. Since vegetation recovery from these impacts is expected within a few years (Yokel et al. 2007), long-term disturbance from ice pads, ice roads, ice airstrips, and snow trails would be negligible.

The construction of well cellars during exploration requires the digging of a hole that destroys vegetation on approximately 64 square feet of ground, replacing that vegetation with bare soils. Alternative B-1 will impact up to 0.2 acre, 50 percent less than under Alternative A.

Development and Production

During oil development and production, various activities could cause impacts to wetlands and floodplains in the NPR-A. These activities include construction of gravel pads for pump stations, staging bases and central processing facilities, roads, airstrips, pipelines, excavation of material sites, summer tundra travel, and construction of ice roads. Impacts of ice roads were discussed in Alternative A.

Construction of central processing facilities and gas compressor facilities, and associated satellite pads, roads, and airstrips, would result in the destruction of vegetation in areas where gravel was placed. All gravel placement taken together would total 5,037 acres.

Blockage of natural drainage patterns can lead to the formation of impoundments, which could alter both the hydrology and species composition of wetlands. Plant productivity could increase, favoring a few species or decrease due to the development of deeper, open water areas. The use of adequate cross drainage structures in gravel roads and attention to the natural drainage patterns during design of developments could help reduce impacts to wetlands from impoundments.

The decreased facilities construction and use under Alternative B-1 would result in a smaller area impacted by dust than under Alternative A. Impacts to plant communities around gravel structures would occur within 164 feet of the structure (Woodward-Clyde Consultants 1983). If all effects were to occur within this zone, a maximum of 20,734 acres would be impacted under Alternative B-1.

Gravel pit excavation and stockpiling of overburden would destroy wetlands at gravel extraction sites. Locating gravel pits an adequate distance from streams and lakes would minimize these impacts, however, most gravel sources will be found in riverbeds and floodplains. It is possible to design gravel pits to enhance fish habitat at the end of the mining operations if they are located in the floodplain. Under Alternative B-1, up to 29 material sites covering 1,007 acres would be required under Alternative B-1 (29 percent less than under Alternative A).

Under Alternative B-1, types of impacts from oil and gas pipeline construction would be similar to those described for Alternative A. A detailed discussion of impacts from pipelines to vegetation is in section 4.3.5.2. A zone of disturbance around the pipeline vertical support members may result in vegetation changes around the vertical support members.

Alternative B-1 could disturb up to 20 acres of vegetation through vertical support member placement. Ice roads built for construction of these pipelines would have only short-term impacts to vegetation, as described above for exploration activities, and would affect 2,565 acres. It is assumed that gas pipelines would be buried, so impacts to vegetation would be different than for oil pipelines. This short-term disturbance for gas-gathering lines, regional, and high-pressure gas pipelines would affect 4,801 acres. Total long-term impacts from burial of these pipelines would be 1,441 acres.

Low-ground-pressure vehicles may be permitted to travel off of gravel pads and roads during periods other than when the ground is frozen and covered with snow. This activity is commonly associated with pipeline inspections and spill-prevention and preparedness measures required in spill-prevention plans during the summer. Impacts under Alternative B-1 would be similar to those described in Alternative A and result in negligible short- and long-term impacts.

Abandonment and Reclamation

Under Alternative B-1, the types of impacts to wetlands and floodplains associated with abandonment and reclamation of gravel roads and pads, pipelines, and other facilities would essentially be the same as those described under Alternative A. Approximately 6,498 acres of gravel fill could be rehabilitated under Alternative B-1, a 23 percent reduction from Alternative A.

Effects of Spills and Gas Releases

Under Alternative B-1, impacts to wetlands and floodplains associated with spills and gas releases would essentially be the same as those described under Alternative A. The reduced amount of leasing, development, and production of oil and gas that would occur under Alternative B-1, relative to Alternative A, would result in a smaller number of small spills of crude and refined oil, produced water and seawater in the NPR-A, but a larger number of gas releases due to the increased miles of regional gas pipelines assumed. The probability of a large oil spill occurrence would also be less under Alternative B-1; but for analysis purposes, it is assumed that only one large spill would occur.

An estimated 11 percent of all spills would occur in the summer and leave gravel pads. This would result in 40 small spills over the life of the plan in Alternative B-1. Assuming an average spill would cover 0.1 acre, an estimated 4 acres could be impacted over the period of development in Alternative B-1, 30 percent less than Alternative A.

A single gas release occurring with ignition could have thermal effects to approximately 194 acres of tundra vegetation. The assumed number of gas releases under Alternative B-1 would result in thermal effects to approximately 504 acres of tundra.

Effectiveness of Stipulations and Best Management Practices

The lease stipulations and best management practices described in Table 2–3 (Volume 1) should effectively reduce the development impacts on wetlands and floodplains under Alternative B-1. Best Management Practices A-1 through A-7 would address solid and liquid-waste disposal, fuel handling, and spill cleanup would be expected to reduce the potential effects of releases, spills, and solid waste on wetlands and floodplain. Best

Management Practice C-2, which addresses overland moves and seismic work, would also effectively minimize impacts to wetlands and floodplains by requiring sufficient depths of frost and snow to protect wetland vegetation. Offsets may be required to avoid using the same route or track in the subsequent year. These requirements will protect streambanks, minimize compaction of soils, and minimize the breakage, abrasion, compaction, or displacement of vegetation.

Application of Lease Stipulations D-1 and D-2, which address activities associated with oil and gas exploration, prohibit drilling in streams and construction of permanent structures during exploratory drilling, and Best Management Practices E-4, E-5, E-6, and E-12, which address design and construction of pipelines, roads, drill pads, airstrips, and other facilities, are expected to effectively minimize the amount of habitat that would be altered by gravel pads and other surface disturbances. Best Management Practice E-8 encourages placement of gravel mine sites outside the active floodplain with conversion to water reservoirs when located within floodplains. Lease Stipulation G-1 would facilitate the regrowth of native vegetation following facility abandonment. The setbacks outlined in lease stipulations (K-1, K-2, K-3, K-4, K-7, K-8, and K-11), which address development near rivers, lakes, and other similar aquatic habitats would be effective at minimizing impacts in high-value wetlands, such as areas dominated by riparian and floodplain habitats. Best Management Practice L-1 would minimize the impacts to wetlands and floodplain of summer tundra travel, if such an action is permitted.

Under Alternative B-1, development would result in fewer impacts to wetlands and floodplains than under Alternative A. The best management practices and lease stipulations associated with Alternative B-1 are quite similar to those of Alternative A, and would provide protections to limit impacts by minimizing destruction of vegetation and alteration of plant communities and floodplain habitat.

Conclusion

Under Alternative B-1, impacts to wetlands and floodplains from activities other than oil and gas would essentially be the same as those described under Alternative A.

Impacts to wetlands and floodplains from oil and gas exploration would occur from seismic work, construction of ice roads and ice pads, and construction of well cellars during exploratory drilling. The duration and recovery time for impacts associated with seismic work would be similar to those for overland moves. Based on earlier studies, there should be no substantial, long-term impacts to wetlands and floodplains from seismic lines, but camp move trails could substantially impact approximately 1,670 acres after 8 to 9 years. Effects of well cellar construction would also be long-term, but would impact less than 0.4 acre of vegetation.

The effects of oil and gas development and operation would include destruction of wetlands during construction of gravel pads (central processing facilities or gas compressor facilities, satellite drill pads, pump stations, and staging bases), roads, and airstrips, from excavation of material sites and burial of gas pipelines, and construction of vertical support members. These impacts would be long-term and would impact about 7,505 acres of the NPR-A. Plant communities could also be altered by dust deposition, salinity of gravel fill used in construction, snowdrifts, and blockage of or change to natural drainage patterns. These impacts would be also be long-term and would impact about 20,734 acres. Spills of oil, other chemicals, and saltwater could occur, and would have long-term impacts; except for those associated with small-size spills, which would be cleaned up immediately, allowing recovery within a few years to two decades.

The potential for many shallow streams, ponds, and wetlands in the Arctic to dry out under a warming climate is increased by the loss of permafrost. These shallow systems depend on snowmelt as their primary source of water, with rainfall gains often negated by evapotranspiration during the summer. Evaporation from these shallow waterbodies is very likely to increase as the ice-free season lengthens. Hence, the water budget of most lake, pond, and wetland systems is likely to depend more heavily on the supply of spring meltwater from winter precipitation to produce a positive annual water balance, and these systems are more likely to dry out during the summer (ACIA 2004).

Climate change could alter species composition, increasing the prevalence of deciduous shrubs and decreasing the prevalence of wetland sedges and grasses, and could greatly influence wetlands through hydrological changes. Warmer soil temperatures are likely to increase thermokarst and increases in sea level may inundate low-lying tundra areas increasing aquatic and wet tundra vegetation types and increase erosion of coastal bluffs (ACIA 2004). Such impacts of climate change could accelerate or exacerbate changes in soil thermal regimes that occur with oil and gas development, potentially leading to greater and/or cumulative impacts (Walker et al. 1987) to wetlands from changes associated with thermokarst.

Areal extent of short-term impacts under Alternative B-1 would be about 28 percent less than for Alternative A. Areal extent of long-term-term impacts under Alternative B-1 would be about 24 percent less than for Alternative A.

4.4.7 Fish

4.4.7.1 Activities Not Associated with Oil and Gas Exploration and Development

The potential types of effects on fish from non-oil and gas activities under Alternative B-1 would be the same as those described for Alternative A in section 4.3.7.1; the frequency and intensity of those activities would be expected to be similar.

4.4.7.2 Oil and Gas Exploration and Development Activities

The following discussion addresses the potential effects of oil and gas activities on freshwater, anadromous, and marine fish and fish habitat found within the NPR-A under Alternative B-1.

Effects of Seismic Surveys

The potential types of effects on fish from seismic surveys under Alternative B-1 would be the same as those described for Alternative A on page 144. Mitigation measures for those effects provided by best management practices and lease stipulations are also essentially the same as those for Alternative A. Best Management Practice K-3b would provide protection to some biologically sensitive areas regarding air gun-based seismic surveys that would require open water. Under this best management practice, oil and gas exploration operations would be restricted in the Kogru River, Dease Inlet, Admiralty Bay, Elson

Lagoon, Peard Bay, Wainwright Inlet/Kuk River, and Kasegaluk Lagoon between May 15 and October 15 each year. Also, Best Management Practice C-2 specifies that winter seismic surveys only occur when most waterbodies are considerably frozen, such that operations would only begin once snow cover and ground frost are sufficient to protect the tundra. Best Management Practice C-3 would provide protection to stream banks by requiring that waterway crossings be made at a low-angle. It would also mandates that any channel crossings reinforced with additional snow or ice be breached before spring breakup to avoid blocking fish migrations. In order to further protect fish overwintering areas, Best Management Practice C-4 would prohibit travel up and down streambeds (unless it could be demonstrated that no impacts will occur to overwintering fish) and would require that rivers and streams be crossed at areas of grounded ice whenever possible. Risks to water quality from petroleum products and waste associated with seismic vehicles and camps would be minimized by Best Management Practices A-2, A-3, A-4, and A-5. These best management practices address the handling of potential pollutants and require prevention and spill response planning.

Under Alternative B-1, effects of seismic surveys on freshwater, anadromous, or marine fish should be localized and primarily impact individual fish in a specific lake or other overwintering location. It can be assumed that the more miles that are surveyed under any given alternative, the greater the probability that effects on fish may occur. The incidence of impacts on fish occurring from seismic surveys under Alternative B-1 (58,338 surveying miles) would be 8 percent more than Alternative A, the same as Alternative B-2, 18 percent less than Alternative C, and 25 percent less than Alternative D.

Effects of Snow Trails, Ice Roads, Ice Pads, and Ice Airstrips

The potential types of effects on fish from snow trails, ice roads, ice pads, and ice airstrips under Alternative B-1 would be the same as those described for Alternative A on page 147. Mitigation measures for those effects provided by best management practices and lease stipulations are also essentially the same as those for Alternative A. Requirements in Best Management Practices A-2, A-3, A-4, A-5, A-6, and D-1 would reduce the risk of pollutants reaching surface waters from vehicles and equipment, fuel storage, work camps, and exploratory drilling. The risk of damaging streambanks or blocking fish migrations would be reduced by Best Management Practice C-3, which would require that waterway crossings be made at a low-angle and that any channel crossings reinforced with additional snow or ice be breached before spring break-up. Two other best management practices would further protect fish overwintering areas. Best Management Practice C-4 specifies that winter transportation "bridges" should be built where water will freeze to the bottom under normal winter conditions, if possible. Best Management Practice B-2 would apply to ice airstrips constructed on lakes and restrict snow removal to areas that will naturally freeze to the bottom.

Under Alternative B-1, effects on freshwater, anadromous, and marine fish from snow trails, ice roads, ice pads, and ice airstrips, and the associated activities that take place on this temporary infrastructure, such as vehicle travel, industrial equipment transport and use, exploratory drilling, and supporting work camps, would likely be localized to a number of discrete locations. Across different alternatives, the anticipated length of ice roads and snow trails is a reasonable relative index of potential effects on fish from winter oil and gas activities. The greater the transportation network, the more supporting infrastructure and associated activities. From this perspective, the expected incidence of impacts on fish from winter oil and gas activities under Alternative B-1 (55,237 ice road or snow trail miles) would be 28 percent less than Alternative A, 7 percent less than Alternative B-2, 46 percent less than Alternative C, and 49 percent less than Alternative D.

Effects of Water Demand

The potential types of effects on fish from water demand under Alternative B-1 would be the same as those described for Alternative A on page 149. Mitigation measures for those effects provided by best management practices and lease stipulations are also essentially the same as those for Alternative A. Withdrawals of unfrozen water from rivers and streams would be prohibited by Best Management Practice B-1, which would allow the removal of ice aggregate from grounded-ice areas. Water withdrawals would be allowed from lakes in the winter, as guided by rules in Best Management Practice B-2, which closely follows current policy utilized by Alaska Department of Fish and Game. This policy sets limits for withdrawal based on maximum depth and fish species present, although flexibility is allowed for site-specific decisions. Limitations on freshwater use from lakes during ice-free periods would still be guided by Best Management Practice B-2. If seawater intake facilities were constructed in the future under Alternative B-1 to enhance supply to oil fields in the NPR-A, it is assumed that the same design safeguards that are successful around Prudhoe Bay would be incorporated to prevent the entrainment of fish. Regardless of the time of year, Best Management Practice B-2 mandates that intake screens would be required in all freshwater sources.

Protective guidelines under Alternative B-1 and the number of studies investigating both freshwater and seawater uses indicate that effects of water demand on freshwater, anadromous, or marine fish should be limited to local, short-term impacts. In evaluating all alternatives, the relative comparison of projected ice infrastructure should be directly related to the expected incidence of impacts on fish from winter water use. Consequently, Alternative B-1(233,478 acres of ice pads, ice airstrips, and ice roads or snow trails) would have an incidence of impacts that is 29 percent less than Alternative A, 28 percent less than Alternative B-2, 46 percent less than Alternative C, and 52 percent less than Alternative D. The more production pads anticipated under an alternative, the greater the need for year-round freshwater for personnel camps. The degree of foreseeable impacts on fish from year-round domestic freshwater demand under Alternative B-1 (75 oil and gas production pads) would be 27 percent less than Alternative A, 9 percent less than Alternative B-2, 49 percent less than Alternative C, and 53 percent less than Alternative D. The year-round need for seawater for waterflooding would be proportional to the number of oil production pads that would exist for an alternative. The probable extent of potential impacts on fish from year-round seawater use under Alternative B-1 (14 oil production pads) would be 13 percent less than Alternatives A and D, the same as Alternative B-2, and 7 percent less than Alternative C.

Effects of Gravel Mining

The potential types of effects on fish from gravel mining under Alternative B-1 would be the same as those described for Alternative A on page 151. Mitigation measures for those effects provided by best management practices and lease stipulations are also essentially the same as those for Alternative A. As guided by Best Management Practice E-8, gravel mine site design and reclamation would be approved by the authorized officer in consultation with other appropriate federal, State, and North Slope Borough agencies. In addition to this multi-agency review, regulatory roles by other agencies should help mitigate potential effects of gravel mining on fish. For example, streams and lakes with documented anadromous fish use in the Anadromous Waters Catalog (Alaska Department of Fish and Game 2011a; Map 3.3.4-2) would be subject to additional protections under Alaska Statutes 16.05.871.

Considering the well-understood impacts associated with instream and floodplain gravel mining, regulations associated with this activity, and the generally positive results demonstrated in other North Slope oil field gravel mines, negative effects on freshwater, anadromous, or marine fish under Alternative B-1 would likely be localized to small drainages where gravel pits are constructed. Foreseeable potential impacts on fish due to gravel mining would be proportional to the maximum number of gravel pits expected under each alternative. The extent of impacts under Alternative B-1 (29 or fewer gravel pits) would be 28 percent less than Alternative A, 6 percent less than Alternative B-2, 44 percent less than Alternative C, and 47 percent less than Alternative D.

Effects of Development Pads, Roads, Airstrips, and Pipelines

The potential types of effects on fish from development pads, roads, airstrips, and pipelines on fish under Alternative B-1 would be the same as those described for Alternative A on page 152. Mitigation measures for those effects provided by best management practices and lease stipulations are also essentially the same as those for Alternative A. Three best management practices would reduce the risk of altering spatial and temporal aspects of streamflow regimes that could impact fish. Best Management Practice E-5 would minimize the impervious surface area of the development footprint and Best Management Practice E-6 would require that natural drainage patterns be maintained at stream and marsh road crossings. Additional hydrology and fish studies required by Best Management Practice E-14 would further assist in determining the appropriate structures to build at stream channel crossings to reduce impacts on fish. The risk of increased pollutant concentrations from vehicle and equipment use, personnel camps, and pipelines would be reduced by Best Management Practices A-2, A-3, A-4, A-5, and Lease Stipulation E-2, while Best Management Practice A-7 would restrict discharge of fluids produced from the oil-development phase.

Several K lease stipulations under Alternative B-1 would provide additional protection to some biologically sensitive areas from development infrastructure. K-1 would establish a range of half-mile to 2-mile development setbacks from a number of major rivers (except in deltas). Permanent oil and gas facilities would be prohibited within these setback areas, except for essential road and pipeline crossings. Similarly, K-2 would establish a quarter-mile development setback from deep-water lakes, defined as those greater than 4 meters, which comprise lake zone IIII (Mellor 1985; Map 3.3.10-1). However, while K-2 would also restrict permanent facilities except essential road and pipeline crossings, it would allow that any facility can be considered on a case-by-case basis. Permanent facilities would be prohibited by K-3 within a quarter mile of Teshekpuk Lake, with no exceptions for roads and pipelines. Finally, K-8b would not permit development infrastructure within the Kasegaluk Lagoon Special Area. Moreover, under Alternative B-1, Teshekpuk Lake and a large area around it; Kasegaluk Lagoon and Peard Bay and a mile-wide area around them;

and Elson Lagoon, Dease Inlet, and Admiralty Bay would not be available for oil and gas leasing, and new non-subsistence infrastructure would be prohibited.

Under Alternative B-1, effects on fish from development pads, roads, airstrips, and pipelines, and associated activities such as vehicle and equipment traffic, personnel camps, and production drilling, should primarily occur in different areas at a small catchment scale; impacts would not be expected to have a significant effect on larger watershed populations of freshwater, anadromous, or marine fish in the NPR-A or adjacent waters. The anticipated length of roads and pipelines is representative of the relative scale of expected development under each alternative. From this standpoint, the incidence of impacts on fish from those structures and associated activities under Alternative B-1 (1,893 miles of roads and pipelines) would be 17 percent less than Alternative A, 8 percent less than Alternative B-2, 50 percent less than Alternative C, and 52 percent less than Alternative D. The incidence of impacts on fish related to gravel pads and airstrips under Alternative B-1 (113 gravel pads and airstrips) would be 27 percent less than Alternative A, 7 percent less than Alternative B-2, 47 percent less than Alternative C, and 51 percent less than Alternative D.

Effects of Causeways

The potential types of effects on fish from causeways under Alternative B-1 would be the same as those described for Alternative A on page 155. Mitigation measures for those effects provided by best management practices and lease stipulations are also essentially the same as those for Alternative A. Lease Stipulation E-3 prohibits the construction of causeways, docks, artificial gravel islands, and bottom-founded structures in river mouths and deltas, and the construction of artificial gravel islands and bottom-founded structures in active stream channels. If any such structures were approved, they would be designed, sited, and constructed in a way meant to prevent large changes in nearshore hydrography and maintain free passage of marine and anadromous fishes. Additionally, a monitoring program would be required to evaluate water quality and fish passage.

Under Alternative B-1, causeways or any other structures that extend into coastal waters could impact anadromous or marine fish along local coastline areas. Under the different alternatives, susceptibility to causeway effects can be based on the estimated length of coastline within available leasing areas for each alternative (Table 4-19). From this perspective, less than 10 percent of the NPR-A coastline (less than 100 miles) would be vulnerable to causeways under Alternative B-1 and B-2. Comparatively, causeways could potentially be built along 100 percent of NPR-A coastline under Alternatives A and D, and 50 percent of the coastline under Alternative C. However, under Alternatives A, B-1, and C (Lease Stipulation K-8b), Kasegaluk Lagoon would be off-limits to permanent oil and gas facilities, while under Alternatives D and B-2, a causeway or similar structure could be constructed there.

Effects of Summer Tundra Travel

The potential types of effects on fish from summer tundra travel under Alternative B-1 would be the same as those described for Alternative A on page 156. Mitigation measures for those effects provided by best management practices and lease stipulations are also essentially the same as those for Alternative A. Summer tundra travel would require a case-by-case evaluation for permitting this type of travel under Best Management Practice L-1, which would provide the opportunity to avoid sensitive areas (e.g., known spawning grounds).

Under Alternative B-1, limited summer tundra travel could affect freshwater or anadromous fish in a number of discrete lakes and streams, but would not likely have any impact on marine fish. Since most approved summer tundra travel would be related to pipeline maintenance, the length of pipelines estimated for each alternative is indicative of the relative extent of potential effects on fish from this activity. Accordingly, the expected incidence of impacts under Alternative B-1 (1,397 miles of all pipelines) would be 12 percent less than Alternative A, 7 percent less than Alternative B-2, 51 percent less than Alternative C, and 52 percent less than Alternative D.

Effects of Oil Spills and Gas Releases

The potential types of effects on fish from oil spills and gas releases under Alternative B-1 would be the same as those described for Alternative A on page 156. Mitigation measures for those effects provided by best management practices and lease stipulations are also essentially the same as those for Alternative A. Those best management practices and lease stipulations include requirements and guidelines for locating pads, roads, and pipelines and associated refueling operations that would reduce the risk of spills or gas releases entering fish habitat. Lease Stipulation E-2 would require that permanent oil and gas facilities and infrastructure be more than 500 feet from ordinary high water marks, with essential pipeline and road crossings evaluated on a case-by-case basis. Under Best Management Practice A-5, equipment refueling within 500 feet of the active floodplain of any waterbody would be prohibited, and fuel storage exceeding 210 gallons would have to be outside of this setback. Other best management practices would help reduce the size of oil spills and gas releases that do occur. Provisions for required impermeable containment, spill prevention, and response planning are included in Best Management Practices A-3 and A-4. Additionally, Best Management Practice E-4 would necessitate that pipelines be built and operated with the best available technology for detecting and preventing corrosion or mechanical defects.

Several K lease stipulations under Alternative B-1 would provide additional protection to some biologically sensitive areas from oil spills and gas releases. K-1 would establish a range of half-mile to 2-mile development setbacks from a number of major rivers (except in deltas). Permanent oil and gas facilities would be prohibited within these setback areas, except for essential road and pipeline crossings. Similarly, K-2 would establish a quarter-mile development setback from deep-water lakes, defined as those greater than 4 meters, which comprise lake zone IIII (Mellor 1985; Map 3.3.10-1). However, while K-2 would restrict permanent facilities except essential road and pipeline crossings, it would allow that any facility can be considered on a case-by-case basis. Permanent facilities would be prohibited by K-3 within a quarter mile of Teshekpuk Lake, with no exceptions for roads and pipelines. Finally, K-8b would not permit development infrastructure within the Kasegaluk Lagoon Special Area. Moreover, under Alternative B-1, Teshekpuk Lake and a large area around it; Kasegaluk Lagoon and Peard Bay and a mile-wide area around them; and Elson Lagoon, Dease Inlet, and Admiralty Bay would not be available for oil and gas leasing and new non-subsistence infrastructure would be prohibited.

Under Alternative B-1, effects on freshwater, anadromous, or marine fish from small crude or refined oil spills and from any gas release should typically be localized. Most gas releases would only present an acute, short-term threat to fish; impacts from liquid (oil and other produced fluid) spills would be much greater. Since most Alaskan North Slope industry spills have been contained on gravel pads and roads (National Research Council 2003), pipeline leaks would be the most likely source for spills that could affect fish. Consequently, the estimated extent of pipelines that would transport liquids under each alternative represents a practical relative risk to fish from small spills. The risk under Alternative B-1 (1,057 miles of pipeline for oil and two- or three-phase produced fluids) would be 22 percent less than Alternative A, 9 percent less than Alternative B-2, 57 percent less than Alternative C, and 57 percent less than Alternative D.

Effects on fish from large oil spills, if a substantial portion reached freshwater, could impact freshwater and anadromous fish populations at a watershed level. If a considerable quantity of a large oil spill reached coastal waters, this could potentially impact anadromous or marine fish populations. The percent chance of one or more large oil spills (Table 4-16) under Alternative B-1 (28 percent) is less than Alternative A (37 percent), Alternative B-2 (30 percent), Alternative C (37 percent), and Alternative D (39 percent).

Effects of Abandonment and Reclamation

The potential types of effects on fish from abandonment and reclamation under Alternative B-1 would be the same as those described for Alternative A on page 159. Mitigation measures for those effects provided by best management practices and lease stipulations are also essentially the same as those for Alternative A. Lease Stipulation G-1 only provides broad guidance for oil and gas field abandonment, requiring that the final disposition of the land must meet the current and future needs of the public.

Effects (negative or positive) on freshwater, anadromous, or marine fish from oil and gas abandonment and reclamation under Alternative B-1 should only occur at individual lakes, small stream reaches, or limited coastline areas. The total area of surface disturbance under the different alternatives should reflect the relative magnitude of potential effects on fish from abandonment and reclamation. As such, Alternative B-1 (13,410 acres of permanent pads, roads, pipelines, and gravel pits) would have an expected incidence of impacts that is 19 percent less than Alternative A, 9 percent less than Alternative B-2, 51 percent less than Alternative C, and 53 percent less than Alternative D.

4.4.7.3 Effectiveness of Stipulations and Best Management Practices

The best management practices and lease stipulations under Alternative B-1 would mitigate potential impacts on fish from oil and gas activities to the extent that effects would likely occur in localized areas, and only a large oil spill would be expected to potentially affect fish at the population level. Best Management Practices A-2 through A-7 would reduce risks to water quality impairment through procedures for handling potential pollutants, preventing spills, and responding to spills. These are largely based on current practices that have worked well in recent exploration activities and in oil and gas development areas to the east of the NPR-A. Water-use guidelines in Best Management Practices B-1 and B-2 correspond with current standards utilized by Alaska Department of

Fish and Game that have resulted in few impacts, as demonstrated by a number of investigations.

Similarly, based on recent field evaluations, winter stream channel crossings have largely met the objectives outlined in Best Management Practices C-3 and C-4. Lease Stipulations D-1, E-2, K-1, K-2, K-3a, K-3b, and K-8b collectively address the placement of exploration and development activities with regard to aquatic resources. Although only speculative, in principle, these setbacks should be effective in reducing the incidence of foreign materials (e.g., sediment or pollutants) reaching surface waters. Best Management Practices E-4 and E-5 would further strengthen the protections provided by these setbacks by requiring that the best available current technology be used to reduce the extent of infrastructure and minimize pipeline spills.

Other best management practices would aim to avoid impacts when infrastructure placement is necessary within or in close proximity to fish habitat. Guidance to prevent roads from effecting fish passage at stream crossings is outlined in Best Management Practices E-1, E-6, and E-14, which would mandate site-specific hydrology and fish studies and that crossing structures be built according to best known practices. Best Management Practice E-8 would require that gravel mines be developed in a manner that would consider effects of current and past North Slope gravel mines, and Lease Stipulation E-3 would prohibit the building of causeways or similar structures that would restrict free passage of anadromous and marine fish, which did occur in Prudhoe Bay in the past. Finally, Lease Stipulation G-1 would mandate abandonment and reclamation following oil and gas development; however, the effectiveness of this practice to minimize or remove impacts on aquatic habitats is unknown.

4.4.7.4 Conclusion

The potential impacts to freshwater, anadromous, and marine fish from oil and gas exploration and development activities within the NPR-A under Alternative B-1 broadly include acoustic disturbance, injury at water-use intakes, altered water quality, physical habitat changes (water quantity, flow patterns, and geomorphology), point and non-point source pollution, increased turbidity and sedimentation, and barriers to fish movements. These impacts can collectively contribute to reduced success at different life history stages, behavioral changes, diminished condition, susceptibility to pollutants or disease, shifts in fish species distribution, and mortality. The best management practices and lease stipulations in Alternatives B-1, B-2, C, and D and the corresponding required operating procedures and lease stipulations in Alternative A would essentially provide the same level of protection to fish. The major exception is that Alternative D has no comparable provisions to Lease Stipulations K-3a and K-3b in Alternatives A, B-1, B-2, and C and Alternatives D and B-2 have no comparable provision to Lease Stipulation K-8b in the other alternatives. The fundamental difference among the various alternatives regarding potential effects on fish is the extent of land that would be open for leasing to conduct oil and gas activities and the distribution of those lands within the NPR-A Fish Habitat Units (Map 3.3.4-1; Table 4-19). Under Alternative B-1, NPR-A lands available for leasing include 16,300 miles of potential stream habitat. This is 8 percent less than Alternative A, 6 percent less than Alternative B-2, 36 percent less than Alternative C, and 52 percent less than Alternative D. The amount of potential lake habitat within lands that may be leased in Alternative B-1 (1,009,500 acres of lake surface area) is 38 percent less than Alternative

A, 1 percent more than Alternative B-2, 39 percent less than Alternative C, and 46 percent less than Alternative D. The distribution of these waterbodies in different NPR-A Fish Habitat Units is described in Table 4-19.

If predicted shifts in physical and chemical characteristics of the environment occur with climate change (e.g., Scenarios Network for Alaska Planning 2010), impacts on fish from oil and gas activities under Alternative B-1 could be greater or less than expected. The factors related to this are the same as those described for Alternative A.

4.4.7.5 Potential New Mitigation Measure (new best management practice)

The objective and requirement or standard would be the same as those described in section 4.3.7.5. The potential benefits and residual or unavoidable impacts would be similar to those described for Alternative A in section 4.3.7.5.

4.4.8 Birds

This section discusses the potential effects to non-special status bird species that could result from management action in the planning area under Alternative B-1. A discussion of effects to threatened and sensitive bird species is given in section 4.4.11.2, "Special Status Species." Most of the activities that could potentially affect birds in the planning area would result from oil and gas exploration and development. Other activities that could potentially affect birds in the planning area include permitted recreational use, guided hunting, activities associated with scientific surveys and research camps, cleanup of old oil and gas exploration sites, and activities associated with government actions (e.g., cleanup of abandoned well sites). These activities could affect tundra-nesting birds by causing: (1) habitat loss, (2) disturbance or displacement (3) increased predation, and (4) direct mortality. Impacts would most often be localized and on the scale of individual birds. Impacts have potential to have greater negative effect if the activity occurs in an area of high bird density (such as near lakes containing large numbers of molting geese or shorebird nesting and staging areas) or in areas containing populations of species known to have declining populations or those particularly sensitive to disturbance. Alternative B-1 would make available approximately 48 percent (11 million acres) of the NPR-A for oil and gas leasing, although leasing in lands currently deferred from leasing (see Alternative A) would not be offered for lease, pending expiration of the deferrals (see Map 2-2). Approximately 11.8 million acres would be unavailable for leasing and five special areas containing 15.5 million acres would be allocated. Management practices would emphasize performance-based stipulations and best management practices on surface activities, consultation with local residents, and coordinated scientific studies to protect wildlife habitat, subsistence use areas, and other resources.

4.4.8.1 Activities Not Associated with Oil and Gas Exploration and Development

Under Alternative B-1, activities not related to oil and gas exploration and development that could affect birds in the planning area would be the same as those described under Alternative A: air traffic, aerial surveys to inventory wildlife or other resources, summer research activities, hazardous material or debris removal, and permitted recreational camps and boating activity. As compared to Alternative A, impacts to birds from non-oil and gas activities could be less frequent, lesser in extent, or shorter in duration under

Alternative B-1. This is because new non-subsistence infrastructure would be prohibited from large areas important for birds and because the lesser amount of oil and gas activity projected in this alternative may reduce the amount of non-oil and gas activity by reducing the impetus for scientific studies. Fewer individual animals likely would be exposed to human activities, including aircraft traffic and aerial surveys. Impacts generally would be localized, and the disturbance reactions of birds would likely be brief. Some birds might avoid scientific and recreation camps during the 6 to 12 weeks of activities, while some birds (e.g., ravens) could be attracted to the camps. Best management practices (see Alternative A for specifics) and large areas in which new non-subsistence permanent infrastructure is prohibited protects birds and their habitats, and would help to mitigate the potential effects of non-oil and gas activities on birds under Alternative B-1.

4.4.8.2 Oil and Gas Exploration and Development Activities

Exploration

Ground-based seismic surveys and exploration activities would occur during the winter months when birds are mostly absent from the planning area. Under Alternative B-1, the types of effects of winter exploration activities would be the same as those discussed under Alternative A. Although the same number of seismic surveys is estimated to take place under both Alternatives A and B-1, the actual area covered by those surveys is expected to be greater in Alternative B-1. The use of air guns for boat-based seismic work would not be allowed in several large coastal bays and lagoons because those lands would be unavailable for leasing (Dease Inlet, Admiralty Bay, Elson Lagoon, Kogru River, Peard Bay, Wainwright Inlet/Kuk River, Kasegaluk Lagoon, and their associated islands). The direct effects of ground-based exploration activities would likely include the temporary displacement of a small number of birds (e.g., ptarmigan and gyrfalcons) from preferred winter feeding or roosting areas.

Alternative B-1 prohibits exploration activities in the same areas and manner as Alternative A (i.e., in Dease Inlet, Admiralty Bay, Elson Lagoon, and associated islands). However, unlike Alternative A, it adds other high-quality bird habitats to the prohibition. This includes the Kogru River, Peard Bay, Kasegaluk Lagoon, and Wainwright Inlet/Kuk River. These areas are very important to many migratory species of waterbirds and shorebirds during critical life stages such as migration staging, molting, and breeding, and therefore, birds would benefit greatly from the protection. During winter, seismic activities would be allowed in these areas (but no shorebirds or waterbirds are present. The types of effects that could result from the construction and use of ice roads and ice pads would be the same under Alternative B-1 as those described under Alternative A, and would primarily involve the temporary alteration of tundra habitats. However, a smaller area (due to large areas that are unavailable for leasing) would be available to oil and gas exploration activities under Alternative B-1, as compared to any of the other alternatives. Therefore, the potential impacts to birds resulting from exploratory activities would likely be less under Alternative B-1 than under any of the other alternatives.

Alternative B-1 contains the same measures as all other alternatives to avoid human-caused increases in predator populations. This includes Required Operating Procedure/Best Management Practice A-2 and Stipulation E-9, which would minimize the availability of anthropogenic food (e.g., garbage) and shelter, respectively that could be utilized by predators. Similarly, measures addressing proper handling of hazardous materials associated with the drilling process and accidental spills are the same among all alternatives as well (i.e., Required Operating Procedures/Best Management Practices A-1 through A-7). Therefore, Alternative B-1 offers no advantage or disadvantage to birds from the handling of waste products.

Under Alternative B-1, oil and gas exploration wells would create an estimated combined short-term ground disturbance of 384 acres, and a long-term ground disturbance of less than 1 acre. Delineation wells would impact the same number of acres, although not necessarily in the same locations as the exploration wells. This is the least amount of short-term bird habitat loss predicted for any alternative, with about 16 percent less than the next lowest alternative (Alternative B-2), and 35 percent less than Alternative A. There is essentially no long-term habitat loss predicted from exploration activities in any alternative.

Development and Production

Under Alternative B-1, the types of development and production activities would be the same as those discussed under Alternative A. In order to mitigate the potential negative effects of activities associated with the oil and gas development and production activities Alternative B-1 includes Stipulations E-2, G-1, K-2, K-3a and b, K-4a, K-6, and Best Management Practice K-8a. Stipulations K-4a and K-6 in Alternative B-1 offer greater protection to birds than do the corresponding stipulations in Alternative A. However, because the amount and location of activities could be different under Alternative B-1, effects to birds could also vary as discussed in detail below.

Habitat Loss

Of all activities, gravel mining and placement for the construction of oil and gas field infrastructure would have the greatest potential to result in the permanent loss of bird habitat. Under Alternative B-1, it is estimated that a total of 520 acres would be disturbed for oil central processing facilities and gas compressor facilities (see Table 4-14). In conjunction with these facilities, other support structures would also be needed, such as gravel production pads, runways, and roads. Under Alternative B-1, the gravel footprint (total long-term disturbance) of these production facilities would be 7,505 acres (Table 4-14). Of all the alternatives, Alternative B-1 is predicted to create the lowest amount of long-term surface disturbance, with about 25 percent less surface disturbance than Alternative A. Much of the area unavailable for leasing in Alternative B-1 is of very high values to many species of birds.

In addition to permanent habitat loss, temporary loss of tundra habitat adjacent to gravel roads and pads could occur as a result of thermokarst, dust deposition, snow accumulation, water withdrawals (if recharge does not occur), and impoundment formation. Under Alternative B-1, the types of effects to birds resulting from temporary habitat loss would be the same as those discussed under Alternative A. However, the potential for loss would likely be less under Alternative B-1 than any other alternative, because of the larger area unavailable for leasing, the resultant reduced need for infrastructure, and the protections imposed on some areas that contain large numbers of birds. The extent of effects from temporary habitat loss would depend on the species and numbers of individuals occurring in areas adjacent to the development.

Bird mortality could result from collisions with vehicles (ground and air) or structures such as elevated pipelines, buildings, drilling rigs, towers, power lines if suspended, boats (including barges), or bridges. Under Alternative B-1, the types of effects to birds resulting from collisions with structures would be the same as those discussed under Alternative A although the potential for collisions would be lower in Alternative B-1 due to the larger area unavailable for leasing and the resultant reduced need for infrastructure. The magnitude of potential impacts to bird populations as a result of collisions in areas of oil and gas development will depend, among other variables, on the location and type of the structure, the species involved, the lighting regime employed, and the weather conditions. Birds would likely be impacted at the level of the individual and not at a population level. The expected number of sealifts in Alternative B-1 would be lower than in the other alternatives, as the amount of supplies needed to build oil and gas infrastructure would be reduced due to the few facilities estimated to be built, so the impacts from bird collisions with barges would also be lower in Alternative B-1.

Disturbance

The potential for disturbance to birds from ground-based travel on roads, within pads, and cross-tundra would likely be less under Alternative B-1 than any other alternative, because Alternative B-1 would make unavailable approximately 11.8 million acres of the NPR-A from oil and gas leasing (including a large tract of important bird habitat east of Dease Inlet and around Teshekpuk Lake), and the resultant reduced need for pads, pipelines, roads, and associated infrastructure. In addition, this alternative would enlarge special areas and create one new special area. Potential impacts from summer cross-country travel on tundra would be limited in Alternative B-1, the same as all other alternatives, and would only be allowed on a case-by-case basis, and only after extensive studies have been conducted (Required Operating Procedure/Best Management Practice L-1).

Aircraft, both fixed-wing and helicopter, would provide access for oil and gas-related activities throughout the development, and operation and abandonment of any oil or gas field developed in the NPR-A. The types of disturbance effects to waterfowl and other bird groups from aircraft would be the same under Alternative B-1 as those discussed under Alternative A, and could include displacement from preferred feeding habitats, temporary or permanent nest abandonment, and temporary or permanent displacement from staging, molting, or brood-rearing areas. Aircraft disturbance would be likely to affect birds in those portions of the NPR-A open to development, with the effects being lowest in Alternative B-1, second in Alternative B-2 followed by Alternative A, with the most disturbance likely to occur in Alternatives C and D.

The types of disturbance effects to waterfowl and other bird groups from watercraft would be the same under Alternative B-1 as those discussed under Alternative A, and could include displacement from preferred habitats and nest abandonment. As the expected number of sealifts in Alternative B-1 would be lower than in the other alternatives, the impacts from bird collisions with barges would also be lower in Alternative B-1.

Oil spill response training activities using watercraft could be conducted on rivers and lakes several times during the open-water period. The potential for disturbance to birds from these activities would likely be less under Alternative B-1 than in any other alternative, because of the larger area unavailable for leasing, the resultant reduced need for infrastructure, and the protections imposed on some areas that contain large numbers of birds. The extent of effects to birds from oil spill and gas release response activities would depend on the species and numbers of individuals occurring in areas within and adjacent to the impacted area.

Predation

Some predators, such as raven, gulls, arctic fox, and bear could be attracted to areas of human activity where anthropogenic sources of food and denning or nesting sites were present. The potential impacts of increased numbers of predators on birds are discussed under Alternative A. Increased predation pressure could have moderate impacts on tundra-nesting birds. Under Alternative B-1, the types of effects to bird populations would be the same as those discussed under Alternative A. Under Alternative B-1, there would be less potential for bird mortality due to predation than under the other alternatives, as there would be fewer anthropogenic sources of food available.

Abandonment and Reclamation

Development scenarios indicate that at abandonment of the field, gravel pads and roads may or may not be removed and that reclaimed or abandoned pads may be revegetated by native vegetation or would be allowed to bed naturally. Given that scenario, it is very difficult to determine potential effects to birds from these unknown activities. For this document, it is assumed that all gravel will be removed after abandonment. Given that assumption, the impacts of abandonment and reclamation of oil and gas fields on birds would be similar in many respects to those incurred by construction activity. The types of impacts would be the same for Alternative B-1 as described in Alternative A. However, Alternative B-1 would likely have the least impact of any alternative, as less area would be available for oil and gas development, resulting in less total area to be abandoned and subsequently rehabilitated.

Oil Spills and Gas Releases

Under Alternative B-1, the types of effects to birds resulting from oil and seawater spills and gas releases would be the same as those discussed under Alternative A.

Although the estimated large oil spill volume is the same for all alternatives, the probability of a spill occurring is notably less under Alternative B-1 (28 percent) than under Alternatives B-2, A, C, and D (30, 37, 37, and 39 percent, respectively). This difference is due to the greater size of the unavailable lands within areas of high potential for oil discovery in Alternative B-1, thus reducing the anticipated oil recovery. Even with the protection of particularly sensitive areas (e.g., coastal shoreline and goose molting area), and the substantial emphasis on spill prevention and response, if a large crude oil spill occurred, it could have a measurable effect on birds at a population level. Effects to individual birds could range from short-term disturbance to death. Impacts to birds on a population level could occur if oil from a large spill entered rivers, important molting or brood-rearing lakes, or marine areas during periods when large proportions of specific populations (e.g., brant, long-tailed ducks, eiders, and shorebirds) were present. Many factors would determine the probability that birds would be negatively impacted by a large oil spill, including the quantity spilled, season, location (e.g., land versus water), and proximity to sensitive habitat. Although the probability of a spill varies by alternative, the impacts to individual birds from large crude/refined oil spills would be the same as under all alternatives if a spill were to occur in a location where birds were present.

Oil entering a river or stream could potentially spread into delta or coastal areas, where impacts to loons, waterfowl, and shorebirds could be more severe. Under all alternatives, the potential that an oil spill would enter a major river or stream would be minimized by Stipulation K-1. This would provide setbacks from specified rivers, within which permanent oil and gas facilities would be prohibited, although pipelines would not necessarily be prohibited in some of these areas.

Oil spilled (from a barge or support vessel) into marine habitats would have the potential to spread oil over a larger area than in terrestrial habitats due to winds and currents; therefore, birds found in marine habitats within NPR-A could be particularly susceptible to the negative impacts of an oil spill. The reduced need for marine transportation under Alternative B-1 relative to the other alternatives would reduce the opportunity for a spill to occur. For further discussion of potential effects of marine spills, see Alternative A.

A gas release from a well is expected to last one day and to release 10 thousand cubic feet of gas, while a release from a transmission pipeline or processing facility is estimated to release 20 thousand cubic feet over a few hours. Although the estimated release volume is the same for all alternatives, the difference in the estimated number of gas production wells and lengths of various pipelines would change the probability of a release among the alternatives. The potential for disturbance to birds from a gas release would likely be less under Alternative B-1, as compared to all other alternatives, because of the larger area unavailable for leasing, the resultant reduced need for infrastructure, and the protections imposed on some areas that contain large numbers of birds.

4.4.8.3 Effectiveness of Stipulations and Best Management Practices

The central theme of Alternative B-1 is the designation of large areas of the NPR-A as unavailable for oil and gas leasing, the creation and expansion of special areas, and the recommendation to Congress that 12 rivers be designated for inclusion in the Wild and Scenic Rivers System as wild. These unavailable lands and designated special areas result in the protection of many natural resources including birds and bird habitat.

Alternative B-1 would make unavailable approximately 11.8 million acres of the NPR-A from oil and gas leasing. About 25 percent of this land is in the northeast area of the NPR-A and it includes, among other values, important waterfowl and shorebird habitat, and this unavailable designation supersedes the current time-limited (2018) deferral north and east of Teshekpuk Lake. Other lands would be unavailable for leasing in Alternative B-1 to protect marine habitat and shorelines important for marine animals, waterfowl, and shorebirds (Kogru River, Elson Lagoon, Dease Inlet, Admiralty Bay, Wainwright Inlet/Kuk River, Peard Bay, and Kasegaluk Lagoon, and their associated barrier islands and, in the case of Peard Bay and Kasegaluk Lagoon, lands within 1 mile of those two waterbodies).

Alternative B-1 would enlarge three existing special areas and create one new special area (see section 2.3.2 in Volume 1). The Teshekpuk Lake Special Area would be expanded to better protect, among other values, waterbird and shorebird habitats. This alternative would expand the Kasegaluk Lagoon Special Area to protect, among other values, waterbird and shorebird breeding, molting, staging, and migration habitats. Alternative B-1 would add approximately 3.1 million acres to the Utukok River Uplands Special Area. Alternative B-1 would also create a Peard Bay Special Area to protect, among other values, habitat for waterbird and shorebird breeding, molting, staging, and migration. The boundary of the Colville River Special Area would not change, but its purpose would be modified to protect all raptors, rather than the original intent of protecting arctic peregrine falcons.

All alternatives, including Alternative B-1, contain numerous stipulations and best management practices that would effectively protect birds and their habitats in the NPR-A (see Alternative A for a full listing). The "B" best management practices would help limit the impact of water withdrawals on lakes, or lake habitats, used by birds, while the "C" best management practices govern seismic ground operations to prevent seismic activity-related disturbance to birds and provide protection for over-wintering fish and invertebrates which are sources of food for many birds. The goose molting area within the Teshekpuk Lake Special Area is protected by Best Management Practice K-4a, which under Alternative B-1, prohibits permanent oil and gas facilities (except pipelines) within 1 mile of the shorelines of goose molting lakes. This best management practice applies to off-lease activities to develop valid existing NPR-A leases as the Teshekpuk Lake Special Area is unavailable for leasing for the life of this plan. In addition, there are numerous best management practices and stipulations that regulate the types of activities that can occur near waterbodies, including rivers and streams, types of equipment that can be used, and types of exploration and development activities that can be conducted in the planning area, to protect birds and their habitats.

Finally, Alternative B-1 provides stipulations and best management practices along with unavailable designations that provide protection to surface resources that is superior to the other alternatives. As there has been no oil or gas development yet in the NPR-A, it is difficult to determine the effectiveness of the above-mentioned best management practices and stipulations. Required operating procedures and stipulations that have been in effect in the NPR-A to date regulate exploratory activities, and thus far, seem to be effective in protecting birds and bird habitats.

4.4.8.4 Conclusion

Alternative B-1 emphasizes the protection of surface resources more than any other alternative, and would be most favorable for birds. It would designate the highest number and acreage of special areas, most of which purposefully include very high-value bird habitats. This alternative would also make the largest amount of high value bird habitat unavailable for leasing; therefore, there would be a reduced need for infrastructure that could cause habitat loss, disturbance, or mortality. A corridor for infrastructure associated with offshore development in the Chukchi Sea could be accommodated.

Alternative B-1 would provide five special areas, including the creation of one new special area and the enlargement of three others. The 1.6-million-acre Peard Bay Special Area would be created with an explicit purpose of protecting nearshore waters for shorebirds and waterbirds. Shorebirds and waterbirds would also benefit from the 2-million-acre addition to Teshekpuk Lake Special Area and the 267,000-acre addition to Kasegaluk Lagoon Special Area. The purpose of two existing special areas would be modified to specifically include birds; shorebirds and waterbirds would also be added to the Teshekpuk Lake Special Area, and all raptors (not just the arctic peregrine falcon, as originally stated) would be added to the Colville River Special Area.

Non-oil and gas activities that could potentially affect birds would be the same as those in Alternative A. Under all alternatives, this analysis shows that impacts to birds from non-oil and gas activities would be minor.

A lower overall level of development would likely occur under Alternative B-1, as compared to all other alternatives. The potential for habitat loss and alteration to affect birds would be less under Alternative B-1, as compared to the other alternatives, as the amount of high-use bird habitat that would be lost to gravel infrastructure would be much less. The potential for bird mortality resulting from collisions with vehicles (air or ground) or infrastructure and marine vessel traffic would be less under Alternative B-1 because the amount of infrastructure and barge traffic would be less than in the other alternatives. The potential for an oil spill to impact birds would also be less under Alternative B-1, as compared to the other alternatives, given the estimated lower amount of infrastructure and development activity, and the large amount of protection afforded to coastal areas in this alternative.

Under Alternative B-1, the types of disturbances related to vehicle, aircraft, pedestrian, and vessel traffic, routine maintenance activities, heavy equipment use, facility noise, and oil spill and gas release cleanup activities would be similar to those described under Alternative A. The potential for these disturbances to impact birds would be far less under Alternative B-1, as a large portion of the high-use bird habitat in the planning area is unavailable for leasing.

Stipulations and best management practices established under Alternative B-1 would help to mitigate potential impacts to birds. Effectiveness of stipulations and best management practices are unknown at this time, but are presumed to be effective.

In general, impacts to birds from non-oil and gas activities, and from oil and gas exploration and development activities, would be additive. Potential impacts from seismic activity would vary by alternative, with Alternatives A and B-1 each expecting to require five exploratory and six developmental seismic surveys. Alternative B-1 is expected to require greater area coverage by seismic survey than does Alternative A, so the total area impacted by seismic survey in Alternative B-1 will be larger than that in Alternative A (see Table 4-11). This larger area of potential seismic activity would likely avail many high value bird habitats as many of those areas are unavailable for leasing in this alternative. The expected number of oil and gas fields and the level of development under Alternative B-1 would be lower than under all of the other alternatives. Therefore, it is expected that the potential effects of disturbance, habitat loss and alteration, and bird mortality due to oil and gas exploration and development under Alternative B-1 would be lower that under any of the other alternatives presented in this plan. The sum of effects from all activities authorized under this alternative, barring a large oil spill, would likely produce no measureable effect on migratory bird populations of any species. All alternatives would minimize unintentional take of migratory birds and conserve migratory bird populations.

Although many of the forces driving global climate regime shifts may originate outside the Arctic, the impacts of global climate change are exacerbated in the Arctic (Arctic Climate

Impact Assessment 2004). Temperatures in the Arctic have risen faster than in other areas of the world, as evidenced by glacial retreat and melting of sea ice. Given that, bird species whose range in Alaska is concentrated in the Arctic may be the most vulnerable to the effects of a changing climate. These species include snow goose, king eider, red phalarope, stilt sandpiper, ruddy turnstone, pomarine jaeger, snowy owl, and Smith's longspur, among others. Effects to birds from climate warming may include a suite of effects, both positive and negative. A longer open-water season may increase productivity of some species of shorebirds and increase productivity in aquatic and semi-aquatic systems, which provide food for many species of birds.

Warmer soil temperatures are likely to increase thermokarst, and increases in sea level may inundate low-lying tundra areas, increasing salt marsh, aquatic and wet tundra vegetation types, and erosion of coastal bluffs (Arctic Climate Impact Assessment 2004) causing changes in coastal habitats that may quickly result in changes in vegetation that influence habitat suitability and availability for birds (Mars and Houseknecht 2007). The increasing thickness of the active layer of soil above arctic permafrost is likely to cause changes in moisture regimes and the distribution of vegetation types over much of the Arctic in coming years. Drying of wetlands would result in negative effects to those species that rely on shallow water and wet meadows, and shrub expansion may reduce the quality and availability of some types of habitats. Such impacts could accelerate or exacerbate changes in soil thermal regimes that occur with development, potentially leading to greater impacts to bird habitat.

Melting sea ice may affect a few bird species, such as black guillemot that feed near the ice edge and may not be able to bring high-quality food to their young as the pack ice moves farther offshore. Increase in human economic activities such as shipping and offshore oil and gas development may influence the abundance and distribution of predators, which may negatively affect bird populations. These changes may be beneficial to some species such as those associated with boreal forest or shrub habitats, but a reduction in the amount of tundra habitat available could negatively impact tundra-nesting shorebirds and waterfowl and add to the cumulative effects of oil and gas development. High rates of coastal erosion and storm surges have led to saltwater intrusion into freshwater habitats, and such intrusions are expected to have altered goose foraging habitats, and may be the cause of the observed spatial redistribution of geese in the Teshekpuk Lake Special Area (U.S. Geological Survey 2006).

4.4.9 Terrestrial Mammals

4.4.9.1 Activities Not Associated with Oil and Gas Exploration and Development

Impacts to mammals from non-oil and gas activities would essentially be the same as those discussed under Alternative A. No further analysis is necessary.

4.4.9.2 Oil and Gas Exploration and Development Activities

Alternative B-1 emphasizes protection of surface resources, while making nearly 11 million acres of federally owned subsurface (48 percent of the total NPR-A) immediately available for oil and gas leasing. In addition, lease stipulations would provide seasonal and spatial protection to certain environmentally sensitive areas, including Rivers Area, Deep Water

Lakes, Colville River Special Area and Coastal Area, and Teshekpuk Lake. The exploration scenario under Alternative B-1 assumes that one 2-D and 10 3-D seismic surveys would be conducted over the next 30 years, the same number as for Alternative A, but involving 9 percent more acreage. It also assumes that 128 oil or gas exploratory or delineation wells, 65 percent of those assumed under Alternative A, would be drilled from winter ice pads over that period. The development scenario under Alternative B-1 assumes that 9 central processing facilities for oil and 19 central processing facilities or gas compressor facilities for gas along with associated production pads and other facilities would be developed in the NPR-A. The exposure of terrestrial mammals to oil and gas activities, and therefore, the level of associated impact, would be less under Alternative B-1 than under the other alternatives, given that leasing of lands in a broad area around Teshekpuk Lake would not occur and the overall scale of development is assumed to be less under Alternative B-1.

Effects of Disturbances

Seismic Activities

Impacts to terrestrial mammals would be nearly the same as those discussed under Alternative A, because it is assumed that the number of terrestrial seismic operations would be the same under both alternatives, but cover 9 percent more acreage under Alternative B-1. The greater change is that seismic surveys would not occur in the broad area around Teshekpuk Lake where no leases would be offered under Alternative B-1. It is expected that the reactions of caribou and other terrestrial mammals to disturbance would be brief, and that fewer numbers of wintering Teshekpuk Caribou Herd caribou would likely be encountered (see Alternative A for a description of potential adverse impacts). Some caribou and other large mammals would likely be displaced from the general area of the seismic work. Some terrestrial mammals would avoid seismic camps, while others, such as foxes, could be attracted to the camps by food odors. The potential for disturbance to hibernating grizzly bears would remain, but bears are present at low density. Impacts to moose would likely be the same as for Alternative A, since there would be no change for the Colville River area where most NPR-A moose winter. Muskoxen may not be affected at all, because all areas currently known to be occupied by mixed-sex groups would be unavailable for leasing.

Under Alternative B-1, Teshekpuk Lake would remain unavailable for leasing. There would be no summer seismic exploration on the lake, and therefore, no disturbance of terrestrial mammals near the lake due to such activity.

Exploratory Drilling

Under Alternative B-1, it is projected that the number of exploration and delineation wells drilled (128) would be less than Alternative A, and even fewer in comparison to Alternatives C or D. Impacts to terrestrial mammals would be similar to those discussed under Alternative A, but somewhat less in spatial extent, frequency, and magnitude. This would especially be so in the areas surrounding Teshekpuk Lake, where leasing would be excluded under Alternative B-1. Exploratory drilling would be conducted during the winter, when some mammal species are less active or less often present, although wintering Teshekpuk Caribou Herd caribou could be present in large numbers. Grizzly bears may experience a reduced level of impacts than under Alternative A, depending on their winter distribution. There may be no difference for moose, or possibly muskoxen, between Alternatives A, B-1, and B-2, due to their distributions relative to where drilling operations may occur. This assumes their distributions would remain similar over the next 30 years to what they are today.

The implementation of lease stipulations and best management practices would minimize impacts to terrestrial mammals by including (1) provisions to avoid known grizzly bear dens by one-half mile, (2) methods to avoid attracting wildlife to food and garbage, (3) provisions to protect streambanks from damage during overland moves, and (4) provisions to minimize the effect of low-flying aircraft on wildlife (particularly over caribou winter ranges).

Oil and Gas Development

Approximately 48 percent of the NPR-A would be made available for leasing under Alternative B-1. Large blocks in the northeast and southwest portions would be excluded from leasing.

The primary effects of oil and gas development on terrestrial mammals would be similar to those outlined under Alternative A, and would result from construction of facilities such as roads and pipelines; motor vehicle traffic within the oil and gas field(s) and on connecting roads; foot traffic near facilities and camps; aircraft traffic; crude-oil and fuel spills contaminating tundra, fresh water, and coastal habitats; and habitat alteration associated with gravel mining and construction. The greatest potential for impacts to caribou would be through disruption of calving areas and interference in the movement of mosquito-harassed Teshekpuk Caribou Herd caribou between insect-relief habitat and foraging areas, but this would be almost completely eliminated under Alternative B-1 due to the two large blocks excluded from leasing. Thus, impacts would likely be less under Alternative B-1 than under Alternative A, given the smaller development scenario that would create less disturbance and affect about 28 percent fewer acres of habitat under long-term disturbance. Functional loss of habitat would be greater than the number of acres indicated as the actual development footprint. Wolfe (2000) suggested that when caribou in the Central Arctic Herd avoided areas within 2.5 miles of roads (during calving season), the functional habitat loss increased from 2 percent (the immediate footprint of roads and gravel pads) to 29 percent.

Caribou, moose, muskoxen, grizzly bears, wolves, wolverines and foxes could be locally affected by activities associated with oil and gas exploration and development. Impacts to mammals would be similar to those discussed under Alternative A, but could be less frequent, lesser in extent, or shorter in duration. A smaller number of individual animals would likely be exposed to human activities. Aircraft traffic would less often pass over caribou and other terrestrial mammals during flights, and less habitat would potentially be permanently lost.

Construction of permanent roads within the NPR-A would increase access to the area and could increase sport and subsistence hunting of terrestrial mammals if those roads were ever connected to villages or other road systems. Among ungulate species, caribou would be most impacted by increased access for hunting, but other species (moose in particular) may also be impacted, depending on the location of permanent roads. The overall number of animals taken would be unlikely to increase dramatically since most hunting would be for subsistence purposes, but roads could focus hunts in particular portions of the NPR-A. Hunting pressure and harvests have increased for many wildlife species near the Trans-Alaska Pipeline System since its construction, but have not produced adverse population effects (Trans-Alaska Pipeline System Owners 2001). It is unlikely that the more remote roads associated with oil and gas development in the NPR-A would have as great an effect on wildlife populations as occurred along the Trans-Alaska Pipeline System corridor.

Caribou – Although much of the construction associated with oil and gas development would occur primarily during winter, development would bring year-round facilities and activities to caribou range. If a field were developed on valid existing leases in the area northwest of Nuiqsut, or in the large area south of Barrow and surrounding Atqasuk, production pads, pipelines, within-field roads, and other facilities would be located within a small portion of the area used by the Teshekpuk Caribou Herd for calving and a larger portion of the areas used for insect relief and wintering. A field development in these areas would also require a connector pipeline to link the oil or gas fields with facilities to the east.

The types of impacts of field development on caribou would be similar to those outlined under Alternative A. However, given the reduced possibility that a field would be developed within the calving, insect-relief, and wintering grounds of the Teshekpuk Caribou Herd caribou, impacts to caribou could be less under Alternative B-1 than under Alternative A. Overall, the level of impact would depend on the specific location of any oil or gas field. For example, a field in the central or northwestern portion of the NPR-A would likely not impact the Teshekpuk Caribou Herd caribou calving grounds, although such a development could still affect migratory movements of Teshekpuk Caribou Herd and Western Arctic Herd caribou, as well as activities on their wintering ground.

The types of impacts of field development on caribou would be similar to those outlined under Alternative A. However, given that fewer fields would likely be developed within the calving, insect-relief, and wintering grounds of the Teshekpuk Caribou Herd, impacts to caribou could be less under Alternative B-1 than under Alternative A. Wilson and Loya (2012) and Wilson (personal communication) suggest through their modeling efforts that the remaining high-quality calving habitat following development would be 92 percent (95 percent confidence interval: 90-93 percent) for Alternative B-1, significantly more than the 78 percent for Alternative A. The Western Arctic Herd caribou could be exposed to oil or gas development facilities in only localized areas outside of their core summer habitats under Alternative B-1.

Traffic associated with hauling gravel from outside of the NPR-A could result in local disturbance and displacement of caribou within one to a few miles of the operations. A pipeline linking oil or gas fields in the NPR-A with facilities at the Alpine and Kuparuk oil fields, or directly to the Trans-Alaska Pipeline System at Pump Station 2, would result in the disturbance and displacement of some caribou during winter construction, due to air traffic and vehicle traffic along ice roads. It is expected that these disturbances would be short term (but see Alternative A's discussion of potential effects of seismic operations) and occur within about one to a few miles of the pipeline corridor.

Oil and gas development within the NPR-A could introduce for the first time such infrastructure and activities into the winter range of a North Slope caribou herd (Teshekpuk Caribou Herd). Previously, no North Slope caribou herd has been exposed to oil gas activities year-round. The Teshekpuk Caribou Herd has experienced seismic exploration and activities near villages for many years, and some herd members on the periphery of the range have been exposed to oil field facilities in some years, but there is no evidence as yet of adverse effects other than increased hunting mortality for those animals close to villages. It is not known what population effects might occur if the majority of the herd were to have year-round contact with oil and gas facilities and activities. Despite the current lack of evidence regarding adverse effects from seismic exploration and village contact, negative effects on caribou energy budgets during winter could result from this new situation. Such an effect could be manifested through increased winter mortality itself, or a reduction in calf productivity.

Muskoxen – Muskoxen occur in low densities in the NPR-A, and they are not present year-round in all years in areas that might be developed under Alternative B-1. Potential effects of oil and gas development activities include displacement and disturbance of individual animals, direct habitat loss from gravel mining in river floodplains and at oil or gas field facilities, and indirect habitat loss through reduced access caused by physical or behavioral barriers created by roads, pipelines, and other facilities. Under Alternative B-1, impacts would be similar to or less than those under Alternative A, since the area around Teshekpuk Lake, where one mixed-sex group has been known to occur, would not be offered for lease.

Moose – Moose occur in low densities in the NPR-A during the summer and are concentrated in major drainages at the eastern edge of the NPR-A in the winter (Map 3.3.6-12). Unless oil or gas fields were developed in the eastern portion of the NPR-A along the Colville River, development would be unlikely to have more than a minor impact on moose. Under Alternative B-1, impacts to moose would be similar to those discussed under Alternative A, because the probability of a development in that portion of the NPR-A would be the same or similar.

If gravel were mined from the eastern portion of the NPR-A, a temporary displacement and disturbance of moose could occur. Borrow pit operations could potentially destroy or degrade up to 1,007 acres of moose habitat if all gravel borrow operations occurred in the eastern portion of the NPR-A (an unlikely scenario).

Dall Sheep – Dall sheep would not be affected by oil or gas activities under Alternative B-1 because the area along the extreme southern edge of the NPR-A where they may occur would not be available for oil or gas leasing.

Grizzly Bears – Major sources of noise include construction of roads, installation of crude oil or gas pipelines, pump or compressor stations, gravel mining, and drilling operations. These activities could disturb grizzly bears within a few miles of the noise sources. Industrial activities and human presence could also cause potentially serious disturbances to denning bears. Under Alternative B-1, impacts to grizzly bears would be similar to those that would occur under Alternative A, although the extent and duration of impacts could be less because of the smaller overall development scenario, depending on the locations of field development. Grizzly bears are present at low densities in the northern portion of the NPR-A, but could be attracted to some activities. It is likely that the greatest number of bears would be encountered during development activities in the central portion of the NPR-A, because the southern portion with the highest densities of bears would not be available for leasing under Alternative B-1.

Wolves – Under Alternative B-1, oil and gas development would have a similar impact on wolves as under Alternative A. Potential effects to wolves would include short-term disturbance from air and surface traffic and human presence, and increased hunting and trapping pressure through improved access or increased human presence associated with oil or gas development. If caribou abundance decreased substantially as a result of oil and gas development, wolf abundance could, in turn, decrease. However, wolves are not abundant in the portions of the NPR-A that would be available for leasing in Alternative B-1, with the possible exception of the Colville River.

Wolverines – The potential effects of oil and gas development on wolverines under Alternative B-1 are the same as under other alternatives, and could include disturbance from air and surface vehicle traffic, increased human presence, and habitat alteration. Because wolverines are considered a shy and secretive species, they could be sensitive to oil or gas exploration and development activities, and abandon habitat areas near development. If development affected caribou abundance, wolverines could be affected in turn. Alteration of riparian habitats through gravel excavation or pipeline construction could affect wolverines, especially during the winter when these habitats provide cover and important hunting areas. Wolverines are present at relatively low density in the portions of the NPR-A available for leasing, with the possible exception of the area along the Colville River, and sightings there have been infrequent. Documented sightings and harvest locations suggest that wolverines could be encountered just about anywhere in the areas available for leasing. Impacts under this alternative are likely to be similar to or slightly less than those that would occur under Alternative A, given the smaller overall development scenario.

Foxes – Under Alternative B-1, impacts to arctic and red foxes would be similar to those discussed under Alternative A, although they could be less in duration and extent. Oil and gas development activities could affect foxes by increasing the availability of food and shelter. An increase in the fox population associated with oil or gas development could affect some prey of foxes (such as ground-nesting birds and molting waterfowl) in the development area and over a region larger than the oil field itself (Burgess et al. 1993).

Effects of Abandonment and Reclamation

Abandonment and reclamation activities are expected to disturb and displace terrestrial mammals in a manner similar to that associated with construction. The intensity of the disturbance might be less than during construction, however, because it is possible that caribou, muskoxen, and other terrestrial mammals would have become habituated to road and air traffic over the course of construction and operation of the facilities. Some individuals could be killed by collisions with road traffic. If roads were left in place and maintained in useable condition upon abandonment, they could continue to provide improved access to hunting areas, with consequent hunting pressure on caribou and other subsistence species. Revegetation of roads, pads, and airstrips, if left in place, would facilitate reclamation of habitat, but plant communities on these raised gravel structures would likely be different from those that prevail in adjacent areas and may include invasive species. Pads, roads, and airstrips could provide some insect-relief habitat for caribou, if left in place (Murphy and Lawhead 2000). If gravel fill was removed and the pad revegetated with vegetation similar to the surrounding plant communities, caribou, and possibly other terrestrial mammals, would use the area. Foam insulating materials that could be used in pad construction could be broken up in the course of removal. If some of this foam escapes being cleaned up, it may be used by foxes as denning material. Depending on the material's toxicity and the amount ingested by a fox, this could cause mortality, though the numbers of foxes killed would likely be very small. Overall, a smaller amount of development is assumed under Alternative B-1 than under Alternative A, providing even less impacts from abandonment and reclamation. Those impacts would likely be expressed over a similar time period, resulting in no population-level effects from these activities in either case.

Effects of Spills and Gas Releases

Spills could involve crude oil, refined products, produced water, or seawater. Typical refined products that are spilled on the Alaska North Slope include aviation fuel, diesel fuel, engine oil, fuel oil, gasoline, grease, hydraulic oil, transformer oil, and transmission oil. The extent of environmental impacts would depend upon the type, location, and amount of materials spilled or released, and the effectiveness of the response. The majority of small spills would be contained on the gravel pad and would have no impact on terrestrial mammals or their habitat. Gas releases could occur at well sites (i.e., over a gravel or ice pad) or from pipelines, the great majority of which would be over tundra.

The impacts of oil spills and gas releases on terrestrial mammals are described under Alternative A (section 4.4.9, "Terrestrial Mammals"). Compared to Alternative A, the risk of oil spills would be less, but still small, under Alternative B-1, given the lower estimate of spills. A total of one large spill is still assumed, but the number of small spills assumed for Alternative B-1 is only 70 percent of that for Alternative A for both crude and refined oil spills. Assumed spill volume is also 30 percent less for crude oil, but 67 percent less for refined oil spills. Since no oil or gas activities would occur in the vicinity of Teshekpuk Lake, the likelihood that a spill would reach the lake under Alternative B-1 is greatly reduced. Because most spills would be small and affect a small area, the majority of impacts to terrestrial mammals would result from disturbance associated with spill cleanup activities rather than direct oiling. The assumed number of gas releases (2.6 incidents = 0.9 incidents per 300 pipe miles times 857 miles of pipe), if ignited, would result in thermal effects to approximately 504 acres of tundra. If a wildfire resulted, additional acreage would burn, the amount depending on season, weather conditions, moisture content of vegetation, and suppression effort.

4.4.9.3 Effectiveness of Stipulations and Best Management Practices

The lease stipulations and best management practices developed to protect terrestrial mammals under Alternative B-1 are largely equivalent to the lease stipulations and required operating procedures designed to do the same under Alternative A. As such, they will provide the same benefits. Notable exceptions to this are an addition to Best Management Practice E-8 to encourage storage and reuse of overburden and sod at material sites or other disturbed sites; the addition of Best Management Practice E-20 to aid in monitoring and assessing wildlife movements during and after construction of infrastructure; an addition to Best Management Practice F-1 to extend the flight restrictions covering the Teshekpuk Lake Caribou Habitat area to the Utukok Uplands Special Area; improved control of ground traffic in Lease Stipulation K-5; a setback of 1 mile rather than ¾ mile along the Kogru River in Lease Stipulation K-6; and a slight increase to the size of the Caribou Movement Corridors in Lease Stipulation K-9. In some cases where areas are unavailable for leasing under Alternative B-1 but are available under Alternative A, those stipulations and best management practices would be moot for Alternative B-1 except for off-lease activities to develop valid existing NPR-A oil and gas leases.

4.4.9.4 Conclusion

Under Alternative B-1, oil and gas leasing and exploration would be precluded in one large block surrounding Teshekpuk Lake and another larger block in the southwestern portion of the NPR-A. In other portions of the NPR-A, lease stipulations and best management practices would provide seasonal and spatial protection to certain environmentally sensitive areas, including the Rivers Area, Deep Water Lakes, the Colville River Special Area and Coastal Area. The exposure of terrestrial mammals to oil and gas activities, and therefore, the level of associated impact, would be less under Alternative B-1 than under the other alternatives, given that leasing of lands surrounding Teshekpuk Lake could not occur and that the overall scale of development is assumed to be less under Alternative B-1.

Among the terrestrial mammal populations that could be affected by management actions under Alternative B-1 are the Teshekpuk Caribou Herd, Western Arctic Herd, and Central Arctic Herd caribou. Caribou could be exposed to helicopter traffic and other human activities associated with resource inventories, seismic operations, exploratory drilling, and pipeline construction. The Teshekpuk Caribou Herd caribou movements within some wintering areas could be disrupted by oil or gas exploration or development activities. Although much of the construction associated with oil and gas development would occur primarily during winter, development would bring year-round facilities and activities into some portions of caribou range where it has not existed in the past. If valid existing leases were developed in the area west of Nuiqsut, production pads, pipelines, within-field roads, and other facilities would be located within areas used by the Teshekpuk Caribou Herd for insect relief, migration, and wintering.

It is expected that impacts to terrestrial mammals in the vicinity of Teshekpuk Lake would be much less under Alternative B-1 than under the other alternatives, particularly with respect to caribou calving and insect-relief habitat. Overall, impacts throughout the NPR-A would be less under Alternative B-1, given the smaller overall scale of the planned development. In general, impacts to mammals from non-oil and gas activities, and from oil and gas activities, would likely be additive, except possibly in those areas where both types of activities occurred simultaneously. Impacts to mammals from exploration and development activities would also be additive, as opposed to compensatory, except possibly for habitat impacts where development occurred in habitats previously disturbed during exploration. In areas where two or more activities occurred, overall impacts would reflect those impacts associated with the first activity and any new impacts associated with later activities.

The two large blocks that would be unavailable for leasing are important to Teshekpuk Caribou Herd and Western Arctic Herd caribou as calving and insect-relief areas, and in the case of the Teshekpuk Caribou Herd, wintering grounds. In addition, some stipulations and best management practices have been revised to provide further protection for caribou and terrestrial mammals and their habitat in general. Based on the amount of habitat with a potential to be directly affected by actual development footprint, the magnitude of impacts to mammals under this alternative would be about 28 percent less than Alternative A. If oil and gas activities occurred in areas with an abundance of caribou or other mammals, or in areas with high-quality habitat, impacts could be greater than those based strictly on number of acres of habitat impacted.

There will be impacts to terrestrial mammals from climate change (section 3.3.6.8 in Volume 1) and from the oil and gas activities expected under Alternative B-1. Whether the combination of impacts from these two sources is additive or compensatory, or synergistic or countervailing, will depend on where and how development and climate change actually play out in the NPR-A. Climate change could make foraging more difficult for herbivores during winter, possibly causing negative, synergistic effects to mammals when combined with disturbance and displacement of mammals by oil and gas activities. Geographic shifts in the vegetation communities of the NPR-A as a result of climate change could have synergistic impacts to mammals if they resulted in a greater proportion of higher quality habitat for any season overlapping with areas of concentrated oil and gas activity. Alternatively, these vegetation community shifts could move important habitat out of the areas affected by oil and gas activity, resulting in a countervailing effect. Climate change may increase the availability of suitable habitat for some species (e.g., shrub habitat for moose) but may reduce suitable habitat for other species. For any terrestrial mammals affected in the latter way, it is likely that adverse impacts of climate change will be additive to any adverse effects of oil and gas activities, and the two combined may have synergistic adverse effects.

4.4.9.5 Potential New Mitigation Measures

Potential Mitigation Measure 1 – Hazing by aircraft (new subparagraph to Best Management Practice F-1)

The objective and requirement/standard would be the same as those described in section 4.3.9.5 for Potential Mitigation Measure 1 – Hazing by aircraft. The potential benefits and residual/unavoidable impacts would be similar to those described for Alternative A at section 4.3.9.5.

Potential Mitigation Measure 2 – Chasing wildlife with ground vehicles (new best management practice)

The objective and requirement/standard would be the same as those described in section 4.3.9.5 for Potential Mitigation Measure 2 – Chasing wildlife with ground vehicles. The potential benefits and residual/unavoidable impacts would be similar to those described for Alternative A at section 4.3.9.5.

4.4.10 Marine Mammals

4.4.10.1 Activities Not Associated with Oil and Gas Exploration and Development

Baleen Whales

Effects of activities not associated with oil and gas exploration and development would be similar to Alternative A. There is a possibility of increased recreational activities in the Special Areas, but no direct effects to gray whales or minke whales are expected.

Toothed Whales

As with Alternative A, the impacts of activities within the NPR-A, but not related to oil and gas exploration and development, would include air traffic; aerial surveys to inventory wildlife or other resources; summer research camps; hazardous material or debris removal; and recreational camps and boating activity. The level of non-oil and gas activities would probably not differ between Alternatives A, B-1, and B-2, thus the effects on beluga whales, narwhals, harbor porpoise, and killer whales would not differ.

Ice Seals

Effects of activities not associated with oil and gas exploration and development would be similar to Alternative A. There could be increased recreational activities in the Special Areas, although no direct effects to spotted or ribbon seals are expected.

4.4.10.2 Oil and Gas Exploration and Development Activities

Baleen Whales

Effects to large whales from oil and gas exploration under Alternative B-1 would be similar to Alternative A, but presumably less. With the maximum amount of land being made unavailable for oil and gas leasing from the coastline east of Barrow and from Peard Bay Special Area and Kasegaluk Lagoon Special Area, presumably there could be fewer industry-related flights over these coastal waters and less noise imparted to the marine environment.

Seismic Activities

Effects from onshore seismic surveys would be similar to Alternative A and are not expected to affect cetaceans. Unavailability of all the coastline east of Barrow and much to the west would further reduce any noise from seismic testing to enter marine waters.

Shipping

Gray whales do react to approaching large vessels in some circumstances (Moore and Clarke 2002), and little is known about the effects of shipping on minke whales. Effects from shipping under Alternative B-1 may be similar to Alternative A, but possibly proportionately less due to less acreage and presumably less oil and gas activity in the NPR-A. The protected marine areas could result in fewer nearshore barge transits in those areas and less noise produced in adjacent marine waters. Large whales are not known to use the Peard Bay and Kasegaluk Lagoon Special Areas. Ship/whale collisions are expected to be relatively rare.

Toothed Whales

Oil and gas exploration, development, and transport activities within the NPR-A could impact beluga whales, harbor porpoises, narwhals, and killer whales in a manner similar to Alternative A, although the level of impacts would likely be less in Alternative B-1. Those disturbances would most likely be from anthropogenic sounds, ship strikes, or habitat degradation. Sound would be produced by vessels and aircraft, seismic operations, construction of facilities close to the coast, or exploration, production, and transport of oil or gas. Vessels supporting activities in the NPR-A could strike whales and porpoises, causing injury or death.

One important difference, relevant to marine mammals, between Alternative A and Alternatives B-1 and B-2 is that in the latter all major coastal waterbodies and adjacent islands are being made unavailable for oil and gas leasing. This includes Kasegaluk Lagoon, Peard Bay, and Elson Lagoon/Dease Inlet/Admiralty Bay. Additionally, no non-subsistence permanent infrastructure would be allowed except for buried pipelines under Wainwright Inlet/Kuk River and no oil and gas exploration would be allowed between May 15 and October 15 under Alternative B-1. These provisions would reduce impacts, compared to Alternative A, to belugas, narwhals, harbor porpoises, and killer whales because activities would not be permitted near many coastal areas and possible aggregation areas. This is especially relevant to beluga whales that annually congregate in and near Kasegaluk Lagoon.

Overall impacts from oil and gas activities in Alternative B-1 would likely be minimal and less than impacts from activities specified in Alternative A.

Ice Seals

Potential types of direct and indirect effects on spotted and ribbon seals from activities authorized under Alternative B-1 do not differ from those described under Alternative A. Oil and gas-related effects, however, would likely be more limited than those disclosed under Alternative A. Alternative B-1 does not allow leasing or oil and gas-related development in the Kogru River, Elson Lagoon, Dease Inlet, Admiralty Bay, Wainwright Inlet/Kuk River, Peard Bay, Kasegaluk Lagoon, associated islands, and lands within 1 mile of Peard Bay and Kasegaluk Lagoon (Map 2-2). This includes more named waterbodies than any other alternative. Unavailability would preclude the possibility of production oil spills directly into these important marine waters, and would protect spotted and ribbon seals from most other direct impacts as well (including facility-related disturbance at spotted seal haulouts). The chance for an onshore spill to reach marine waters would also be more effectively minimized under this alternative due to the inclusion of twice as many rivers with setbacks in the K1 Stipulation, and more coastal area included in Stipulation K-6. Both species would still be sensitive to refined oil spills and discharge related to shipping traffic in support of onshore activities. Spotted seals may also be affected by aircraft flights and marine traffic near terrestrial haulouts the same as in Alternative A.

4.4.10.3 Effectiveness of Stipulations and Best Management Practices

Baleen Whales

The effectiveness of stipulations and best management practices would be similar to that of the stipulations and required operating procedures in Alternative A, although Stipulation K-3b would offer greater protection by including more coastal waters.

Toothed Whales

The stipulations and best management practices, as they relate to marine mammals for Alternative B-1 are similar to the required operating procedures and stipulations in Alternative A. One notable exception is Stipulation K-3b. In Alternative B-1, this stipulation expands the protection for coastal areas. Stipulation K-3 under Alternative A protects Elson Lagoon/Dease Inlet/Admiralty Bay, whereas Alternative B-1 also protects Peard Bay, Kasegaluk Lagoon, and Wainwright Inlet/Kuk River. Under Alternative B-1, effectiveness of the best management practices to protect beluga whales and other marine mammals are expected to be better than the required operating procedures under Alternative A.

Ice Seals

The stipulations and best management practices of Alternative B-1, as they relate to ice seals, are similar to the required operating procedures and stipulations in Alternative A. Notable exceptions are Stipulations K1, K-3b, K-8b, and Best Management Practice C-1. In Alternative B-1, Stipulation K1 would more effectively minimize the chance that an onshore oil spill would reach marine waters by including twice as many rivers as what are named in Alternative A. StipulationK-3b similarly expands the protection for coastal areas by adding more major coastal waterbodies in its provisions: the Kogru River, Peard Bay, Kasegaluk Lagoon, and Wainwright Inlet/Kuk River. Stipulation K-8b extends the no permanent development restriction to one mile inland from the lagoon. The areas covered by Stipulations K-3b and K-8b would be unavailable for leasing, and therefore under this alternative would be a best management practice with applicability only to off-lease activities. Stipulations and provisions for areas made unavailable for leasing are expected to be effective at minimizing impacts to spotted and ribbon seals within these areas. In addition, seals would be adequately protected within Special Areas, such as Kasegaluk Lagoon where marine mammals are specifically listed as a main value to protect. Discharge from support vessels may not be effectively regulated through the A-series required operating procedures, and could result in impacts to both species.

4.4.10.4 Conclusion

Baleen Whales

Under Alternative B-1, most impacts will remain associated with marine shipping and barging. Most of the impacts on gray and minke whales would be disturbances related to marine noise, but ship/whale collisions are a possibility. Population-level effects are unlikely.

Toothed Whales

Impacts to belugas, narwhals, harbor porpoises, and killer whales under Alternative B-1 would likely be short-term and local, and would be less than those under Alternative A due to the increased amount of land assigned Special Area status and made unavailable for leasing. The most likely impact would be displacement from preferred habitats or disturbance to normal behavior due to anthropogenic sounds mostly from activities not associated with oil and gas. These impacts would likely be localized and temporary and not incur population-level changes.

Ice Seals

Under Alternative B-1, the greatest effect to spotted seals from non-oil and gas-related activities will likely be in the form of haulout disturbance by aircraft and marine vessel traffic. Effects will likely be short term and of the same magnitude as presented in Alternative A. Ribbon seals are unlikely to be affected by non-oil and gas activities due to their pelagic nature. Types of impacts to spotted seals from oil and gas activities will be similar to non-oil and gas activities, but will also include the chance of an accidental large or very large contaminant spill, and higher potential for the introduction of pathogens from increased marine vessel traffic. Relative to Alternative A, the potential for impacts from oil and gas activities is greatly decreased due to an increase in special areas and lands made unavailable for leasing, and changes in Stipulations K1, K-3b, and K-8b, and Best Management Practice C-1. These impacts cannot be accurately predicted, but large numbers of spotted seals could be affected if perturbations occur at major haulouts where seals congregate during the open-water season. Due to their absence from the nearshore area, ribbon seals are only likely to experience adverse effects from an accidental very large contaminant spill that is not effectively cleaned near the source, or the introduction of new pathogens to the system. Alternative B-1 would limit the potential for development activities to negatively impact seals in and adjacent to the NPR-A planning area more than any other alternative.

Climate change effects, such as sea-ice loss, could affect the susceptibility of ice seals to impacts from development. How these species will react to predicted changes in sea-ice conditions is unknown at this time. Spotted seals have the capacity to adapt by using other haulout substrates such as terrestrial areas. Such a change however, would put them at greater risk from both non-oil and oil and gas activity disturbance onshore. Ribbon seals, which are a pelagic species and primarily dependent on seasonal sea ice for molting and whelping, may be less vulnerable to the combined effects of sea-ice changes and oil and gas development activities. The mechanisms by which effects of climate change and anthropogenic activities interact are unknown and could range from synergistic to countervailing.

4.4.10.5 Potential New Mitigation Measures

Potential Mitigation Measure 1-- Aircraft Avoidance of Seal Aggregations (Addition to F-1 Best Management Practice)

The objective and requirement/standard would be the same as those described in section 4.3.10.5 for Potential Mitigation Measure 1— Aircraft Avoidance of Seal Aggregations. The potential benefits and residual/unavoidable impacts would be similar to those described for Alternative A at section 4.3.11.5.

Potential Mitigation Measure 2—Marine Vessel Avoidance of Terrestrial Aggregations of Seals (Addition to K-6 Stipulation - Coastal Area)

The objective and requirement/standard would be the same as those described in section 4.3.10.5 for Potential Mitigation Measure 2— Marine Vessel Avoidance of Terrestrial Aggregations of Seals. The potential benefits and residual/unavoidable impacts would be similar to those described for Alternative A at section 4.3.11.5.

4.4.11 Special Status Species

The following discussion of impacts is divided into four sections that discuss special status species of plants, birds, terrestrial mammals, and marine mammals.

Within each subsection, authors describe impacts of non-oil and gas activities and oil and gas activities and the effectiveness of stipulations and best management practices and then provide a conclusion (where the discussion is long enough to warrant one). All potential new mitigation measures for special status species are discussed at section 4.3.11.5.

4.4.11.1 Special Status Species of Plants

Nine plant species listed as BLM Sensitive Species and their habitats are described in section 3.3.8 in Volume 1. All of these have been found within the outer boundaries of the NPR-A. An additional 12 species designated as sensitive by BLM-Alaska have been documented on the North Slope, but have not yet been documented in the NPR-A. The types of impacts to these plant species are the same as those for all other vegetation. These impacts are described in section 4.4.5 and are not repeated here.

Under Alternative B-1, development would be unlikely to affect any plant species' existence or any plant communities at scales larger than local effects. However, if development facilities were constructed in an area containing a population of a BLM Sensitive plant species (by definition rare), the impacts to that population, and thus the species, could be severe. Some of the habitats potentially occupied by sensitive species would be protected from development under Alternative B-1 by setbacks along rivers and lakes. Other species occur in dry habitats associated with bluffs, floodplains, river terraces, sand dunes, rocky outcrops, and fellfields. These habitats are the primary sources of gravel fill used during construction and development (National Research Council 2003) and could be impacted by development in these areas.

4.4.11.2 Special Status Species of Birds

This section discusses the potential direct and indirect effects to threatened, endangered, and sensitive bird species that could result from management actions in the NPR-A under Alternative B-1. This includes yellow-billed loon, spectacled eider, Steller's eider, Kittlitz's murrelet, red knot, short-eared owl and golden eagle (collectively referred to as special status species below). All of these species are migratory and do not occur in the NPR-A during winter.

Most of the activities that could potentially affect these special status birds in the NPR-A would result from oil and gas exploration, development and transport.

Other activities that could potentially affect birds include permitted recreation, guided hunting, activities associated with scientific surveys and research camps, cleanup of oil and gas exploration sites, and activities associated with government actions (e.g., cleanup of abandoned well sites). These activities could affect tundra-nesting special status birds by causing: (1) habitat loss; (2) disturbance or displacement; (3) increased predation; and (4) direct mortality. Impacts would most often be localized and on the scale of individual birds.

Alternative B-1 would make available approximately 48 percent (11 million acres) of the NPR-A for oil and gas leasing (Map 2-2). Approximately 11.8 million acres would be unavailable for leasing and five Special Areas containing 15.5 million acres would be allocated. Management practices would emphasize performance-based stipulations and best management practices on surface activities, consultation with local residents, and coordinated scientific studies to protect wildlife habitat, subsistence use areas, threatened eiders species and other resources.

Activities Not Associated with Oil and Gas Development and Exploration

Under Alternative B-1, activities not related to oil and gas exploration and development that could affect special status species in the NPR-A would be the same as those described under Alternative A: air traffic; aerial surveys to inventory wildlife or other resources; summer research activities; hazardous material or debris evaluation and presence and removal; and permitted recreational camps and boating activity. As compared to Alternative A, impacts to eiders from non-oil and gas activities could be less frequent, lesser in extent, or shorter in duration under Alternative B-1. Fewer individual animals likely would be exposed to human activities. This is because new non-subsistence infrastructure would be prohibited from large areas important to some special status species and because the lesser amount of oil and gas activity projected in this alternative may reduce the amount of non-oil and gas activity by reducing the impetus for scientific studies. Aircraft traffic would less often pass overhead of special status species during flights to or from the camps and along aerial survey routes. Impacts would generally be localized, and the disturbance reactions of special status species would likely be brief. Some special status species might avoid scientific and recreation camps during the 6 to 12 weeks of activities, while their predators (e.g., ravens) could be attracted to the camps. Best management practices and large areas in which new non-subsistence permanent infrastructure is prohibited protect birds and their habitats and would help to mitigate the potential effects of non-oil and gas activities on special status species under Alternative B-1.

Oil and Gas Exploration and Development Activities

Exploration

Ground-based seismic surveys to collect geological data and exploration activities occur during the winter months when special status species are absent from the NPR-A. Therefore, these activities would likely have no direct impacts on these species. Although the same number of seismic surveys is estimated to take place under both Alternatives A and B-1, under Alternative B-1 the indirect impacts to the eiders and yellow-billed loon associated with winter exploration would be less than those under the other alternatives as many areas of high value to these species would be unavailable for leasing, therefore, exploration activities in those areas are unlikely to occur.

Alternative B-1 prohibits exploration activities in the same areas and manner as Alternative A (i.e., in Dease Inlet, Admiralty Bay, Elson Lagoon, and associated islands). However, unlike Alternative A, it adds other high-quality bird habitats to the prohibition. These include the Kogru River, Peard Bay, Kasegaluk Lagoon, and Wainwright Inlet/Kuk River. These areas are very important to many special status species during critical life stages such as migration staging, molting, and breeding, and therefore, special status species would benefit greatly from the protection. During winter, when exploration activities would be allowed (but no special status species are present), indirect impacts could result from the construction of ice roads and ice pads, and the associated water withdrawal. The types of effects that could result from the construction and use of ice roads and ice pads would be the same under Alternative B-1 as those described under Alternative A, and would primarily involve the temporary alteration of tundra habitats. Water withdrawal for ice road construction could also temporarily alter habitats adjacent to water source lakes, which could affect nesting or brood-rearing loons and eiders. However, a smaller area would be available to oil and gas exploration activities under Alternative B-1, as compared to any of the other alternatives. Therefore, the potential impacts to special status species resulting from exploratory activities would likely be less under Alternative B-1 than under any of the other alternatives.

Alternative B-1 contains the same measures as all other alternatives to avoid human-caused increases in predator populations. This includes Required Operating Procedure/Best Management Practice A-2 and Stipulation E-9, which would minimize the availability of anthropogenic food (e.g., garbage) and shelter, respectively that could be utilized by predators. Similarly, measures addressing proper handling of hazardous materials associated with the drilling process and accidental spills are the same among all alternatives as well (i.e., Required Operating Procedures/Best Management Practices A-1 through A-7). Therefore, Alternative B-1 offers no advantage or disadvantage to special status birds from the handling of waste products.

Under Alternative B-1, oil and gas exploration wells would create an estimated combined short-term ground disturbance of 408 acres, and a long-term ground disturbance of less than 1 acre. Delineation wells would impact the same number of acres, although not necessarily in the same locations as the exploration wells. This is the least amount of short-term bird habitat loss predicted for any alternative, with about 25 percent less than the next lowest alternative (Alternative A). There is essentially no long-term habitat loss predicted from exploration activities in any alternative.

Development and Production

Under Alternative B-1, these types of development and production activities would be the same as those discussed under Alternative A. However, because the amount and location of activities could be different under Alternative B-1, effects to the special status birds could also vary, as discussed in detail below.

Habitat Loss. Of all activities, gravel mining and placement for the construction of oil and gas field infrastructure would have the greatest potential to result in the permanent loss of habitat for short-eared owl, yellow-billed loon, and spectacled and Steller's eiders. Under Alternative B-1, it is estimated that a total of 520 acres would be disturbed for central processing facilities and gas compressor facilities (see Table 4-14). In conjunction with these facilities, other support structures would also be needed, such as gravel production pads, runways, and roads. Under Alternative B-1, the gravel footprint (total long-term disturbance) would be 7,825 acres (see Table 4-14). If spectacled and Steller's eider densities are assumed to be 2.2 and 0.02 birds per square mile (640 acres per square mile) respectively (very high estimates based on aerial survey data; Larned et al. 2006; Ritchie and King 2003), up to 13 spectacled eiders and 0.1 Steller's eider could be expected to be displaced by the gravel footprint over the life of the plan if all development occurred in high-density areas. This is likely a high estimate because areas of "high" eider density make up only a relatively small proportion of the NPR-A (Map 3-33). Of all the alternatives, Alternative B-1 is predicted to create the lowest amount of long-term surface disturbance with about 25 percent less surface disturbance than Alternative A.

In addition to permanent habitat loss, temporary loss of tundra habitat adjacent to gravel roads and pads could occur as a result of thermokarst, dust deposition, snow accumulation, water withdrawals (if recharge does not occur) and impoundment formation. Under Alternative B-1, the types of effects to special status species resulting from temporary habitat loss would be the same as those discussed under Alternative A. However, the loss would likely be less under Alternative B-1 than any other alternative, because of the larger area unavailable for leasing, the resultant reduced need for infrastructure, and the protections imposed on some areas that contain large numbers of yellow-billed loon and spectacled eiders. The extent of effects to special status species from temporary habitat loss would depend on the number of individuals occurring in areas within and adjacent to the development.

Mortality to special status species could result from collisions with vehicles (ground and air), structures such as elevated pipelines, buildings, drilling rigs, towers, power lines if suspended, boats (including barges), or bridges. Any species of bird may be vulnerable to collision under certain circumstances (see Alternative A); in fact, it is one of the few ways that golden eagle, short-eared owl, Kittlitz's murrelet, or red knot could potentially be impacted under any alternative. The potential for collisions by any special status bird species would be lower in Alternative B-1 than any other alternative due to the larger area unavailable for leasing and the resultant reduced need for infrastructure. However; mortality from collisions would be minor under any alternative. All of the special status species would likely be impacted at the level of the individual and not at a population level.

Disturbance. The potential for disturbance to special status birds from ground-based travel on roads, within pads, and cross-tundra would likely be less under Alternative B-1 than any other alternative. This is because of the larger area unavailable for leasing (including a large tract of important spectacled eider habitat east of Dease Inlet and around Teshekpuk Lake), and the resultant reduced need for pads, pipelines, roads, and associated infrastructure. In addition, this alternative would enlarge Special Areas and create one new Special Area. Potential impacts from summer cross-country travel on tundra would be limited in Alternative B-1 the same as all other alternatives, and would only be allowed on a case-by-case basis, and only after extensive studies have been conducted (Required Operating Procedure/Best Management Practice L-1).

Aircraft, both fixed-wing and helicopter, would provide access for oil and gas-related activities throughout the development, operation, and abandonment of any oil or gas field developed in the NPR-A. The types of disturbance effects to special status species from aircraft would be the same under Alternative B-1 as those discussed under Alternative A, and could include displacement from preferred feeding habitats, temporary or permanent nest abandonment, and temporary or permanent displacement from staging, molting, or brood-rearing areas. Aircraft disturbance would likely be lowest in Alternative B-1, second in Alternative B-2, with the greatest level of disturbance likely to occur in Alternatives C and D.

The types of disturbance effects to special status species from watercraft would be the same under Alternative B-1 as those discussed under Alternative A, and could include displacement from preferred habitats and nest abandonment. As the expected number of sealifts in Alternative B-1 would be lower than in the other alternatives, the impacts from yellow-billed loon and eider collisions with barges would also be lower in Alternative B-1.

Oil-spill-response training activities using watercraft could be conducted on rivers and lakes several times during the summer. The potential for disturbance to some special status species from these activities would likely be less under Alternative B-1 than any other alternative, because of the larger amount of area unavailable for leasing, the resultant reduced need for infrastructure, and the protections imposed on some areas that contain large numbers of yellow-billed loons and eiders. The extent of effects to yellow-billed loons and eiders from oil spill and gas release response activities would depend on the number of individuals occurring in areas within and adjacent to the impacted area.

Predation. Some predators, such as raven, gulls, arctic fox, and bear could be attracted to areas of human activity where anthropogenic sources of food and denning or nesting sites were present. The potential impacts of increased numbers of predators on eiders are discussed under Alternative A. Increased predation pressure could have moderate impacts on any of the special status species. Under Alternative B-1, there would be less potential for increased predation than under the other alternatives, as there would be less human activity and anthropogenic sources of food available.

Abandonment and Reclamation

Development scenarios indicate that at abandonment of the field, gravel pads and roads may or may not be removed and that reclaimed or abandoned pads may be revegetated by native vegetation or would be allowed to bed naturally. Given that scenario, it is very difficult to determine potential effects to special status species from these unknown activities. For this document, it is assumed that all gravel will be removed after abandonment. Given that assumption, the impacts of abandonment and reclamation of oil and gas fields on eiders would be similar in many respects to those incurred by construction activity. The types of activities would be the same for Alternative B-1 as described in Alternative A. However, Alternative B-1 would likely have less impact than the other alternatives, as less total area would be available for oil and gas development, resulting in less total area to be abandoned and subsequently rehabilitated.

Oil Spills and Gas Releases

Under Alternative B-1, the types of effects to special status species resulting from oil and seawater spills and gas releases would be the same as those discussed under Alternative A.

Although the estimated large spill volume is the same for all alternatives, the probability of a spill occurring is notably less under Alternative B-1 (28 percent chance) than under Alternatives B-2, A, C, and D (30, 37, 37, and 39 percent chance, respectively). This difference is due to the greater size of the lands unavailable for oil and gas leasing within areas of high potential for oil discovery in Alternative B-1, thus reducing the anticipated oil recovery. Even with the protection of particularly sensitive areas (e.g., coastal shoreline), and the substantial emphasis on spill prevention and response, if a large crude oil spill occurred, it could have a measurable effect to most of the special status species at a population level. Exceptions to this would be the species whose range only peripherally includes the NPR-A or adjacent marine waters, such as golden eagle, red knot, and Kittlitz's murrelets, or those not associated with water (e.g., golden eagle and short-eared owl). Effects to individual birds that make contact with oil or oiled forage could range from short-term disturbance to death. This applies to all of the special status species regardless of how uncommon they are; in fact, this is one of the few ways that red knot, Kittlitz's murrelet, or golden eagle could potentially be impacted by any alternative. Impacts to special status species (especially yellow-billed loon and eiders) on a population level could occur if oil from a large spill entered rivers, important molting or brood-rearing lakes, or marine areas during periods when large proportions of those species are present. Many factors would determine the probability and extent to which birds would be negatively impacted by a large oil spill, including the quantity spilled, season, location (e.g., land versus water), and proximity to sensitive habitat. Impacts to special status species from large crude or refined oil spills under Alternative B-1 would be less than under all other alternatives.

Oil entering a river or stream could potentially spread into delta or coastal areas, where impacts could be more severe to staging or molting yellow-billed loons and spectacled or Steller's eiders. An oil spill in coastal zone and nearshore habitats of the Colville River Delta, Harrison Bay, Smith Bay, Dease Inlet, Elson Lagoon, or Kasegaluk Lagoon, which support large congregations of threatened eider species, could affect large numbers of individual birds. Under all alternatives, the potential that an oil spill would enter a major river or stream would be minimized by Stipulation K-1. This would provide setbacks from specified rivers, within which permanent oil and gas facilities would be prohibited, although pipelines may be allowed in some of these areas.

A gas release from a well is expected to last one day and to release 10 thousand cubic feet of gas while a release from a transmission pipeline or processing facility is estimated to release 20 thousand cubic feet over a few hours. Although the estimated release volume is the same for all alternatives, the difference in the estimated number of gas production wells and lengths of various pipelines would change the probability of a release between the alternatives. The potential for disturbance to special status species from a gas release would likely be less under Alternative B-1, as compared to all other alternatives, because of the larger area unavailable for leasing, the resultant reduced need for infrastructure, and the protections imposed on some areas that may contain large numbers of special status species.

Effectiveness of Stipulations and Best Management Practices

The central theme of Alternative B-1 is the designation of large areas of the NPR-A as unavailable for oil and gas leasing, the creation and expansion of Special Areas, and the recommendation to Congress that 12 rivers be designated for inclusion in the Wild and Scenic Rivers System as Wild. These unavailable lands and designated areas of special importance result in the protection of many natural resources including special status species (especially spectacled and Steller's eiders) and their habitats.

Alternative B-1 would make approximately 11.8 million acres of the NPR-A unavailable for oil and gas leasing. About one quarter of this land is in the northeast area of the NPR-A and it includes, among other values, important spectacled eider nesting and brood-rearing habitat and supersedes the current time-limited (2018) deferral north and east of Teshekpuk Lake. Other lands would be unavailable for leasing in Alternative B-1 to protect marine habitat and shorelines, which include areas important for spring and fall staging and migration of spectacled and Steller's eiders (Elson Lagoon, Dease Inlet, Admiralty Bay, Wainwright Inlet/Kuk River, Peard Bay, and Kasegaluk Lagoon, and their associated barrier islands and, in the case of Peard Bay and Kasegaluk Lagoon, lands within 1 mile of those two waterbodies).

Alternative B-1 would enlarge three existing Special Areas and create one new Special Area (see section 2.3.2). The Teshekpuk Lake Special Area would be expanded to better protect, among other values, eider nesting and brood-rearing habitats. This alternative would expand the Kasegaluk Lagoon Special Area to protect, among other values, yellow-billed loon and eider molting, staging, and migration habitats. Alternative B-1 would add approximately 3.1 million acres to the Utukok River Uplands Special Area. Alternative B-1 would also create a Peard Bay Special Area to protect, among other values, habitat for yellow-billed loon and eider staging and migration.

All alternatives including Alternative B-1 contain numerous stipulations and best management practices to effectively protect special status species and their habitats within the NPR-A. These include Best Management Practices A-1 and A-2, which address the proper storage, handling, and disposal of solid, liquid, and hazardous wastes (including fuels), as well as Best Management Practices A-3 through A-7, which address hazardous material releases and oil spills through prevention, storage, handling, and disposal. The protection of special status birds, their habitats, and food sources are addressed by Best Management Practices B-1, B-2, C-2, C-3, C-4, D-2, E-9, E-12, E-18, Protection J, and Stipulations E-2 and L-1, among others. Protection J would help minimize the take of species listed under the Endangered Species Act, as would Best Management Practices E-11 and E-18, which contain specific language aimed at reducing impacts to spectacled and Steller's eiders, including their nests and brood-rearing areas. A series of stipulations, including K-3, K-4, and K-8, provide additional protections in biologically sensitive areas and many of these provide protections to eider habitats and food sources. The "B" best management practices would help limit the impact of water withdrawals on lakes, or lake habitats, used by eiders, while the "C" best management practices govern seismic ground operations to prevent seismic activity-related disturbance to eiders and provide protection for over-wintering invertebrates which are sources of food for eiders. The Teshekpuk Lake Special Area would be unavailable for leasing, and permanent oil and gas facilities (with the exception of pipelines) would be prohibited. This would restrict the total area that can be developed within areas that are used in high density by nesting spectacled eiders. In addition, there are numerous best management practices and stipulations that would protect some special status species and their habitats by regulating the types of activities that can occur near waterbodies, including rivers and streams, types of equipment that can be used, and types of exploration and development activities that can be conducted in the planning area.

Finally, Alternative B-1 provides stipulations and best management practices along with making lands unavailable for leasing that provide protection to surface resources that is superior to the other alternatives. As there has been no oil or gas development yet in the NPR-A, it is difficult to determine the effectiveness of the above-mentioned best management practices and stipulations. Best management practices and stipulations that have been in effect in the NPR-A to date regulate exploratory activities, and thus far, seem to be effective in protecting special status species and their habitats.

Conclusion

Alternative B-1 emphasizes the protection of surface resources more than any other alternative, and would be most favorable for special status species. It would designate the highest number and acreage of Special Areas, most of which purposefully include very high-value bird (especially for spectacled eider) habitats. This alternative would also make larger areas unavailable for leasing than other alternatives, and therefore, would have a reduced need for infrastructure that could cause habitat loss, disturbance, or mortality. A corridor for infrastructure associated with offshore development in the Chukchi Sea could be accommodated.

Alternative B-1 would provide five Special Areas, including the creation of one new one and the enlargement of three others. Special Area designation does not itself impose specific protections, but instead highlights areas and resources for which BLM will extend "maximum protection" consistent with exploration of the Reserve. The 1.6-million-acre Peard Bay Special Area would be created with an explicit purpose of protecting nearshore waters for waterbirds. Spectacled eiders and yellow-billed loons use this area during spring and fall. Yellow-billed loons, eiders and red knot would also benefit from the 2-million-acre addition to Teshekpuk Lake Special Area and the 267,000-acre addition to Kasegaluk Lagoon Special Area. The purpose of two existing Special Areas would be modified to specifically include birds; shorebirds and waterbirds would also be added to the Teshekpuk Lake Special Area, and all raptors (not just the arctic peregrine falcon, as originally stated) would be added to the Colville River Special Area.

Non-oil and gas activities that could potentially affect special status species would be the same as those in Alternative A. Under all alternatives, this analysis shows that impacts to special status species from non-oil and gas activities would be minor.

A lower overall level of development would likely occur under Alternative B-1, as compared to all other alternatives. The potential for habitat loss and alteration to affect special status bird species would be less under Alternative B-1, as compared to the other alternatives, as the amount of high use habitat that would be lost to gravel infrastructure would be much less. The potential for mortality resulting from collisions with vehicles or infrastructure and marine vessel traffic would be less under Alternative B-1, because the amount of infrastructure and barge traffic would be less than in the other alternatives. The potential for an oil spill to impact special status birds would also be less under Alternative B-1, as compared to the other alternatives, given the reduced need for infrastructure and development activity and the protections afforded to coastal areas and other important habitats. Stipulations and best management practices established under Alternative B-1 would help to mitigate potential impacts to eiders, yellow-billed loons, and other special status bird species.

Under Alternative B-1, the types of disturbances related to vehicle, aircraft, pedestrian, and vessel traffic, routine maintenance activities, heavy equipment use, facility noise, and oil spill and gas release cleanup activities would be similar to those described under Alternative A. The potential for these disturbances to impact special status birds would be much less under Alternative B-1, as a large portion of the high-use bird habitat is unavailable for leasing.

Stipulations and best management practices established under Alternative B-1 would help to mitigate potential impacts to special status species. Effectiveness of stipulations and best management practices is unknown at this time, but they are presumed to be effective.

In general, impacts to special status species from non-oil and gas activities, and from oil and gas exploration and development activities, would be additive. Potential impacts from seismic activity would vary by alternative with Alternatives A, B-1, and B-2 each expecting to require five exploratory and six developmental seismic surveys, although Alternative B-1 is expected to require greater area coverage by seismic survey than does Alternative A so the total area impacted in Alternative B-1 will be larger than that in Alternative A (see Table 4-11). Alternatives C and D are estimated to require 14 and 16 total seismic surveys, respectively, which will cover a greater area than would be needed in Alternative B-1. The expected number of oil and gas fields and the level of development under Alternative B-1 would be lower than under all of the other alternatives. Therefore, it is expected that the potential effects of disturbance, habitat loss and alteration, and eider mortality due to development under Alternative B-1 would be lower that under any of the other alternatives presented in this plan. All alternatives would minimize unintentional take of migratory birds and conserve migratory bird populations. The special status species susceptible to the greatest amount and types of impacts include those that regularly breed on NPR-A's tundra, where most activities would occur (i.e., Steller's eider, spectacled eider, yellow-billed loon, and short-eared owl). The remaining species (golden eagle, red knot, and Kittlitz's murrelet) would be infrequently exposed to activities, and would be susceptible primarily just to collisions and oil spills. In the absence of a large oil spill, none of the special status species would be expected to incur population-level effects from full implementation of Alternative B-1.

Although many of the forces driving global climate regime shifts may originate outside the Arctic, the impacts of global climate change are exacerbated in the Arctic (Arctic Climate Impact Assessment 2004). Temperatures in the Arctic have risen faster than in other areas of the world, as evidenced by glacial retreat and melting sea ice. Special status species whose range in Alaska is concentrated in the Arctic may be the most vulnerable to the effects of a changing climate. These species include yellow-billed loon, spectacled and Steller's eiders, and red knot. Effects to these special status species from climate warming may include a suite of effects, both positive and negative. A longer open-water season may increase productivity of some species of shorebirds and increase productivity in aquatic and semi-aquatic systems, which provide food for yellow-billed loon and spectacled and Steller's eider.

Warmer soil temperatures are likely to increase thermokarst, and increases in sea level may inundate low-lying tundra areas, increasing salt marsh, aquatic and wet tundra vegetation types, and erosion of coastal bluffs (Arctic Climate Impact Assessment 2004) causing changes in coastal habitats that may quickly result in changes in vegetation that influence habitat suitability and availability for spectacled and Steller's eiders (Mars and Houseknecht 2007). The increasing thickness of the active layer of soil above arctic permafrost is likely to cause changes in moisture regimes and the distribution of vegetation types over much of the Arctic in coming years. Drying of wetlands would result in negative effects to spectacled and Steller's eiders that rely on shallow water and wet meadows, and shrub expansion may reduce the quality and availability of some types of habitats. Such impacts could accelerate or exacerbate changes in soil thermal regimes that occur with development, potentially leading to greater impacts to special status species habitat. Increase in human economic activities such as shipping and offshore oil and gas development may influence the abundance and distribution of predators, which may negatively affect special status species populations. These changes may be beneficial to some special status species such as those associated with boreal forest or shrub habitats (golden eagle), but a reduction in the amount of tundra habitat available could negatively impact spectacled and Steller's eiders, red knot, and short-eared owl and add to the cumulative effects of oil and gas development. High rates of coastal erosion and storm surges have led to saltwater intrusion into freshwater habitats and such intrusions may alter foraging and brood-rearing habitats for spectacled and Steller's eiders.

4.4.11.3 Special Status Species of Terrestrial Mammals

Two species of terrestrial mammals listed as BLM Sensitive Species are described in section 3.3.8 in Volume 1. Neither of these has been found within the NPR-A in recent decades. The Alaskan hare has not been reported on the North Slope since 1951, and the Alaska tiny shrew has never been documented in the NPR-A. The types of impacts to these two mammalian species would be the same as those for all other terrestrial mammals. These impacts are described in section 4.4.9 and are repeated here only briefly.

Under Alternative B-1, development would be unlikely to affect either of these two species, primarily because it is unlikely that either exists in the NPR-A. This is especially so for the Alaskan hare, since if this relatively large-bodied species occurred in the NPR-A, it would most likely have been documented one or more times in the last 60 years. It is more likely that the Alaska tiny shrew has occurred or does occur in the NPR-A without having been documented. If development facilities were constructed in an area containing a population of Alaska tiny shrew, adverse impacts to that population could occur. These impacts would most likely be manifested in the loss of habitat, and could also involve the deaths of some individuals if they were to be run over by heavy equipment during construction of development facilities.

4.4.11.4 Special Status Species of Marine Mammals

Activities Not Associated with Oil and Gas Development and Exploration

Baleen Whales

Effects of activities not associated with oil and gas exploration and development on bowhead, fin, and humpback whales would be similar to Alternative A.

Ice Seals

Aircraft and vessel traffic are the non-oil and gas activities most likely to have a direct impact on ringed and bearded seals. The potential effects of these activities are described under Alternative A. Impacts from activities not associated with oil and gas exploration and development would not differ from Alternative A. Non-oil and gas related impacts would be negligible.

Polar Bear

Winter overland travel is the non-oil and gas activity likely to have the most effect on polar bears in the planning area. Potential impacts to polar bears from this and other activities are described in Alternative A. No difference in the potential to impact polar bears, nor in the level of impact, would be expected between Alternatives A and B-1.

Pacific Walrus

Potential impacts from non-oil and gas activities would be similar to those discussed under Alternative A. The non-oil and gas activities with the most potential to impact walrus in the planning area are noise and visual disturbances from aircraft, vessels, and land-based traffic. No difference in the potential to impact walrus, nor in the level of impact, would be expected between Alternatives A and B-1.

Oil and Gas Exploration and Development Activities

Baleen Whales

Effects to large whales from oil and gas exploration under Alternative B-1 would be similar to Alternative A, but presumably less. With the entire coastline east of Barrow and much to its west unavailable oil and gas leasing, there would be fewer industry-related flights over these waterbodies and less noise imparted to the marine environment, and less potential for contamination or spills associated with development and production.

Seismic Activities. Effects from onshore seismic surveys would be similar to Alternative A, and not expected to affect bowhead, fin, or humpback whales. The unavailability of a large portion of the coastline from leasing would further reduce any noise from seismic testing to enter marine waters.

Shipping. Effects from shipping under Alternative B-1 may be similar to Alternative A, but possibly proportionately less due to less acreage and presumably less oil and gas activity in NPR-A. The protected marine areas could result in fewer nearshore barge transits in those areas and less noise produced in adjacent marine waters if beachheads were established in those areas. Ship/whale collisions are expected to be relatively rare.

Ice Seals. Potential types of direct and indirect effects on ringed and bearded seals from oil and gas activities authorized under Alternative B-1 do not differ from those described under Alternative A. Oil and gas-related effects to these species under Alternative B-1, however, would be more limited than those listed under Alternative A. Alternative B-1 does not allow leasing or oil and gas-related development in the Kogru River, Elson Lagoon, Dease Inlet, Admiralty Bay, Wainwright Inlet/Kuk River, Peard Bay, and Kasegaluk Lagoon (Map 2-2), associated islands, and, in the case of Peard Bay and Kasegaluk Lagoon, lands within 1 mile of those two waterbodies. This is more named waterbodies than in any other alternative. Unavailability would preclude the possibility of production oil spills directly into these important marine waters, and would protect ringed and bearded seals from most other direct impacts as well. The chance for onshore spills to reach marine waters would also be greatly minimized under this alternative compared to Alternative A due to the inclusion of twice as many named rivers with setbacks in the K-1 stipulation, and more coastline added to the K-6 stipulation. Both species would still be sensitive to refined oil spills and discharge related to shipping traffic in support of onshore activities Seals may also be affected by aircraft flights and marine traffic near terrestrial haulouts similar to Alternative A.

Polar Bear

Seismic Activities. Less overall disturbance to polar bears from seismic surveys would be expected under Alternative B-1 than under Alternative A. Seismic surveys conducted within approximately 5 miles of the coast could expose undetected denning polar bears to noise and associated disturbances, resulting in the displacement of maternal polar bears and their dependent cubs, abandonment of the den, and possible death of polar bear cubs. Best Management Practice C-1 would prohibit cross-country use of heavy equipment and seismic activities within one mile of known polar bear dens and require operators to consult with the U.S. Fish and Wildlife Service before initiating activities in coastal habitat between October 30 and April 15. Depending on the suitability of the area for polar bear dens, operators may also be required to survey for dens prior to seismic activities. This combination of procedures minimizes the chance that denning polar bears would be disturbed by seismic activities. Impacts to individual female polar bears and cubs would only occur in the unlikely instance that a den would go undetected during a survey. No population-level impacts are anticipated.

Exploration. Areas unavailable for leasing under Alternative B-1 would include the coastal waterbodies' islands and one mile inland from Kasegaluk and Peard Bay. No exploratory drilling or non-subsistence permanent infrastructure would be allowed within unavailable lands, except for that associated with valid existing NPR-A leases and the Wainwright Inlet/Kuk River subsurface pipeline. Polar bears, present in coastal and marine habitats that are included in the unavailable acreage, could benefit from a lack of industry-related disturbance. It is estimated there could be up to 32 oil exploration and delineation wells and 96 gas exploration and delineation wells drilled under Alternative B-1. These wells are expected to be drilled from ice pads, causing short-term ground disturbance of 192 and 576 acres, respectively. The actual number of exploratory wells with potential to affect polar bears is not currently known; but only those wells drilled within 25 miles of the coast would have the potential to directly affect polar bears, and only those within 5 miles of the coast would have the potential to affect denning polar bears.

Exploratory drilling near the coast during winter (December to mid-April) would potentially disturb, displace, or attract polar bears. As described under Alternative A, the primary threat to polar bears would be disturbance to females in maternal dens and attraction of non-denning bears to support facilities.

Conservation measures have been established to protect female polar bears denning within 1 mile of construction activity. Best Management Practice C-1 would require all industrial activities maintain a one-mile buffer around known or suspected polar bear dens. In addition, oil and gas exploration activities within polar bear habitat would require coordination by the operator with the U.S. Fish and Wildlife Service to locate any potential polar bear dens prior to winter exploration activities.

Lease Stipulations and Best Management Practices A-1 and A-2, which would require proper waste prevention, handling, and disposal, should be effective in preventing or minimizing attraction of polar bears. Best Management Practice A-8, requiring implementation of a bear-interaction plan, would reduce the likelihood of negative human-bear encounters. These plans include measures to minimize attraction of bears to industrial facilities, methods for communicating to workers about bears in the area, and an outline of proper procedures to follow in the event that bears are observed near industrial facilities and work sites. Lessees would be required to keep a systematic record of bears on site and in the immediate area, which could be used to inform future stipulations and policies intended to minimize human-bear conflicts. Such requirements for facility management and human-bear interaction plans have been successfully implemented at oil and gas exploration and production facilities in other portions of the North Slope. It is anticipated that impacts to polar bears attracted to exploration activities in the planning area would also be minimized and actively managed to promote human safety, while limiting detrimental effects to the bears.

Development and Production. Under Alternative B-1, fewer coastal areas would be open for oil and gas leasing than under Alternative A. Surface disturbances would include gravel production pads and central processing facilities for oil and gas, gravel roads, gravel runways, and several types of pipelines (some of which may be buried). Under Alternative B-1, the long-term disturbance would be 7,505 acres. The actual number of development and production facilities (and associated acreage), with potential to affect polar bears is unknown at present. Only facilities within 25 miles of the coast are likely to directly affect polar bears, and facilities within 5 miles of the coast could affect maternal dens.

Impacts to polar bears, including disturbance, caused by development and production activities would likely be less than those described for Alternative A, since some coastal areas would be unavailable for oil and gas leasing while this IAP/EIS is in effect.

The same avoidance and mitigation measures that would be employed during exploration would be utilized during development and production, including avoiding denning polar bears by one mile, minimizing polar bear attraction to facilities, developing human-bear interaction plans, and implementing training for facility personnel. Additionally, Best Management Practice E-5 would require that facilities be designed to minimize impacts of the development footprint, while Best Management

Practice E-4 would require sound pipeline construction to minimize leaks and thus would help minimize take of listed species.

Oil Spills and Gas Releases. Alternative B-1, like Alternative A, poses some risk of small and large spills of oil, refined fuel, and produced water and potential for gas releases. These events could happen at any time of the year. Polar bears could come into contact with unrecovered oil on land, on ice, or at sea. The results to the physical health of the bear would be the same regardless of location.

The impacts of oil spills and gas releases on polar bears are described in detail under Alternative A. Direct oiling could lead to hypothermia and result in increased energy costs or death. Oiled polar bears would ingest oil by grooming, and polar bears could also ingest oil by eating oiled seals or carcasses. Ingested crude oil is highly toxic to polar bears (Oritsland et al. 1981; Stirling 1990). Exposure to oil or associated fumes could cause respiratory distress and inflammation of mucous membranes and eyes, leading to abrasions and ulcerations. Even partial oiling of a polar bear is likely to result in mortality, while chronic low levels of exposure could result in sublethal effects that reduce fitness.

Compared to Alternative A, the risk of oil spills under Alternative B-1 would be less, given the lower estimate of spills. The number of small spills assumed for Alternative B-1 is only 70 percent of that for Alternative A for both crude and refined oil spills. Although the likelihood of an individual bear coming into contact with a small spill is very low under Alternative A, polar bears could avoid coastal areas that were fouled by oil or be displaced by response activities, which could result in impacts to fitness, breeding success, or survival. Alternative B-1 reduces the risk of these impacts from small spills. Effects of a small spill would be short-term (days to weeks), localized, and at most should affect very low numbers of individuals.

The risk of large spills for each alternative is based on the volume of oil expected to be produced over the life of the oil exploration and development that might proceed from leasing and discoveries in the NPR-A. For Alternative B-1, the percent chance of one large spill occurring is 28 percent. The risk of a large spill is lower under Alternative B-1 than under any of the other alternatives. The potential impacts to polar bears resulting from a large oil spill are discussed in Alternative A. Under any of the alternatives, the extent of impacts from a large oil spill would depend on the size, location, and timing of spills relative to polar bear distributions and on the effectiveness of spill response and cleanup. A population-level effect may be expected if a spill were to contact an aggregation of bears. Polar bears are generally widely dispersed in the planning area; and, in the event of a large oil spill, it is most likely that only a small number of polar bears would be directly affected through oiling. However, even a few individuals removed from threatened populations of polar bears could be significant to the recovery of the local population, particularly if females or females with cubs are oiled. Response activities associated with a large spill also have the potential to disturb or affect polar bears; displace them from feeding, resting, and denning areas; and potentially contaminate their food chain.

As stated under Alternative A, there is a small potential that a large gas release could occur from a platform, pipeline, or onshore facility. Direct impacts to polar bears would be minimal because gas would quickly dissipate. Although a bear in the immediate vicinity could potentially experience impacts from inhaling gas, or be injured or killed if an explosion occurred with the release, these scenarios are unlikely. Impacts to polar bears may occur as a result of response activities. If disturbance causes polar bears to be excluded from feeding, resting, or denning areas, this could impact body condition, breeding success, or survival.

Effects of Abandonment and Reclamation. Effects of abandonment and reclamation would generally be similar to those under construction (in both the exploration and development and production stages). Human activities, particularly visual and noise components, could disturb individual polar bears, including both denning and non-denning bears. Disturbing known denning polar bears would be avoided as during construction activities. No population-level effect would be expected.

Pacific Walrus

Under Alternative B-1, impacts to walrus from oil and gas activities would be very unlikely because of the relatively restricted areas of the Chukchi Sea coast that would be available for oil and gas exploration and development. Two objectives of the Peard Bay Special Area and the Kasegaluk Lagoon Special Area are to protect marine mammals (including walrus) in their summer shoreline habitat and to prevent contamination of marine waters. Under Alternative B-1, no leasing would be allowed in Kasegaluk Lagoon or Peard Bay or on lands within 1 mile of those waterbodies, and permanent facilities would not be allowed along the coast of either of these Special Areas. In addition, Lease Stipulation K-6 would not allow permanent oil and gas facilities (including gravel pads, roads, airstrips, and pipelines) within the coastal area, which includes all barrier and offshore islands within the NPR-A and a coastal strip extending three-quarters of a mile inland from all areas managed by the BLM along the Chukchi Sea coast. These protections would benefit walrus by restricting oil and gas development in the vicinity of several known walrus haulout areas on the NPR-A Chukchi Sea coast.

Effectiveness of Stipulations and Best Management Procedures

Baleen Whales

The effectiveness of stipulations and best management practices should be similar to the effectiveness of stipulations and required operating procedures in Alternative A, though Stipulation K-3b would offer greater protection by including more coastal waterbodies.

Ice Seals

The stipulations and best management practices, as they relate to ice seals, for Alternative B-1 are similar to the required operating procedures and stipulations in Alternative A. Notable exceptions are Stipulations K1, K-3b, K-6, K-8b, and Best Management Practice C-1. In Alternative B-1, Stipulation K1 would more effectively minimize the chance that an onshore oil spill would reach marine waters by including twice as many rivers as are named in Alternative A. Also, a number of rivers would have larger setbacks than in any other alternative. StipulationK-3b similarly expands the protection for coastal areas by adding more major coastal waterbodies in its provisions: Peard Bay, Kasegaluk Lagoon, and Wainwright Inlet/Kuk River. Stipulation K-8b extends the no permanent development restriction of Kasegaluk Lagoon to one mile inland from the lagoon. The areas covered by Stipulations K-3b and K-8b would be unavailable for leasing, and therefore under this alternative would be a best management practice with applicability only to off-lease activities. Stipulation K-6 would be improved under Alternative B-1 by adding more coastline to the restriction on development. Under Alternative B-1, stipulations and provisions for not leasing certain coastal areas would be effective at minimizing impacts to ringed and bearded seals within these areas. Seals would be adequately protected within Special Areas, particularly Kasegaluk Lagoon, which was created because of its value to marine mammals and coastal protection of Stipulation K-6. Stipulations would not protect ringed and bearded seals against large spills and discharge from marine traffic associated with development activities. Best Management Practice C-1 is made more effective in this alternative than in Alternative A, due to the explicit requirement for operators to conduct a survey to detect (and then avoid) seal birthing lairs for activities during the seal pupping season (through April 15). Ringed seal pups will be adequately protected only if lairs are identified.

Polar Bear

Many of the lease stipulations and best management practices in Alternative B-1 would provide effective protection for polar bears and their habitats within the planning area. Best Management Practices A-1 through A-8 would ensure that solid, liquid, and hazardous wastes do not attract polar bears or degrade their habitat. They would also require a public safety plan that includes bear-interaction plans to avoid or minimize potential human-bear conflicts. Best Management Practice C-1 would prohibit seismic activities and the use of heavy equipment within 1 mile of known polar bear dens and would require lessees to comply with requirements under the Marine Mammal Protection Act. Best Management Practice E-5 would require that facilities be designed to minimize impacts of the development footprint, while Best Management Practice E-4 would require sound pipeline construction to minimize leaks; these practices help minimize take of listed species. Best Management Practice I-1 would require orientation programs for oil and gas personnel, informing them of the importance of not disturbing biological resources, including endangered species and marine mammals. Protective measure J indicates the BLM would not approve any activity that may affect a listed species, until it completes its obligations under applicable requirements of the Endangered Species Act. Best management practices and Lease Stipulations K-1, K-3, K-4, K-6, and K-8 through K-11 would confer some benefits to polar bears. These stipulations would: (1) limit activities along the banks of rivers and some lakes, reducing sources of disturbance in potential denning habitat; (2) limit activities in coastal habitats, reducing the potential for sources of disturbance and obstructions in this polar bear movement corridor; and (3) require year-round spill response capability during periods of broken ice or open water in certain inlets, bays, lagoons, and barrier islands important to polar bears.

Pacific Walrus

The measures that offer the greatest protection for Pacific walrus are the provisions of Alternative B-1 and Stipulation K-6 that result in no leasing and no new permanent non-subsistence infrastructure in certain areas important to this species, as described in section 4.3.11.4, "Special Status Species of Marine Mammals." Best Management Practice I-1 would require lessees to implement a program to inform personnel about the importance of not disturbing biological resources, including marine mammals. This required operating procedure should minimize direct disturbance to walrus from human activities.

Under Alternative B-1, the Kasegaluk Lagoon Special Area would consist of lands unavailable for leasing. So K-8 would become a best management practice whose provisions would apply only to off-lease activities to develop valid existing NPR-A oil and gas leases outside of the Kasegaluk Lagoon. The K-8 requirement would not permit permanent oil and gas surface facilities within the boundary of the Special Area.

Conclusion

Baleen Whales

Under Alternative B-1, most impacts to bowhead, fin, and humpback whales will be associated with marine shipping and barging, as in Alternative A. With all the coastline east of Barrow and much to its west unavailable oil and gas leasing under Alternative B-1, there would be fewer industry-related flights over these waterbodies and less noise imparted to the marine environment, and less potential for contamination or spills associated with development and production than under Alternative A. Most of the impacts would be disturbances related to marine noise, but there is a possibility of ship/whale collisions. Population-level effects are unlikely.

Ice Seals

Non-oil and gas-related activities will have negligible impacts to ringed and bearded seal populations under Alternative B-1 similar to Alternative A. Alternative B-1 will more effectively protect bearded and ringed seals against development pressures primarily due to the expanded regions unavailable for leasing, including Kasegaluk Lagoon, Peard Bay, Admiralty Bay, and other important habitats used for resting and pupping, particularly for ringed seals. The most likely impact to ringed and bearded seals under Alternative B-1 from non-oil and gas-related activities could be haulout disturbance by aircraft, but this will be negligible due to relatively low number of flights and benign nature of seal response. Impacts to ringed and bearded seals from oil and gas activities may also include the potential for an accidental large or very large contaminant spill, and for ringed seals, disturbance to pupping lairs. While these impacts have the possibility of negatively impacting ringed and bearded seals, the area in which they could apply is greatly reduced in this alternative. Ringed seal pups would be adequately protected if lairs are surveyed and avoided as directed by Best Management Practice C-1. Alternative B-1 provides for a dramatic increase in areas unavailable for leasing and Special Areas that include coastal habitat important to these species. This added protection will lessen the effects of development on these species and will provide the most protection of the four Alternatives, but some negative impacts could still occur to bearded and ringed seal using marine areas in or near the NPR-A planning area.

Climate change effects of habitat loss through diminished sea-ice extent and concentration could have increased adverse effects for these species when coupled with development. Ice-dependent species, such as ringed and bearded seals, may be more susceptible to effects of oil and gas activities due to the added stresses associated with these changes in sea-ice habitat. How either species will adapt to predicted changes in sea ice and snow conditions is currently under debate. Ringed seals have the greatest potential for negative effects through the loss of ice substrate for hauling out during critical energetic periods and lower quality pupping areas. Bearded seals are most likely to be impacted by sea ice loss through reduced availability of ice upon which to haul out for resting or pupping, reduced access to and reductions in prey resources throughout their range from oceanographic changes associated with sea ice loss that favor more pelagic seal species (Cameron et al. 2010). The combined effects of climate change and development activities would be reduced under Alternative B-1 compared to Alternative A.

Polar Bear

Alternative B-1 would make approximately 11 million acres (about 48 percent) of the NPR-A available for oil and gas leasing. About 11.8 million acres would be unavailable for leasing, including portions of a new 1.6-million-acre Peard Bay Special Area and an enlarged Kasegaluk Lagoon Special Area of 364,000 acres. It is expected that under Alternative B-1, the potential effects of disturbance, habitat loss and alteration, and potential mortality due to development would be lower than that under Alternatives A, B-2, C, and D.

Non-oil and gas activities would be highly localized (e.g., worksites or camps) and/or transient (e.g., surveys and inventories). While non-oil and gas activities may result in disturbance to individual polar bears and may prevent some polar bears from using small portions of habitat temporarily, the activities are not anticipated to have long-term impacts to individual polar bears or measurable impacts at the population level. Consultations with U.S. Fish and Wildlife Service under the Endangered Species Act will address potential impacts associated with permitted non-oil and gas activities. Oil and gas activities may likewise result in disturbance to individual polar bears and may prevent some polar bears from using small portions of their habitat temporarily. Endangered species consultations will address those oil and gas activities that could affect polar bears and their critical habitat. Population-level impacts are, therefore, not expected as a result of oil and gas activities, with the exception of a large oil spill. Under some scenarios, a large oil spill could result in population-level effects or long-term impacts to the food chain. The likelihood of such an event is lower under Alternative B-1 than under the other alternatives.

The primary concern for the Southern Beaufort Sea and Chukchi/Bering Sea polar bear populations, of which some portion of both use the NPR-A, is loss of sea ice. The U.S. Fish and Wildlife Service and U.S. Geological Survey have predicted that without changes in the rate of sea ice loss, the polar bear may not occur over much of its current range in the next 40 to 75 years (see section 3.3.8 in Volume 1). Alternative B-1 provides for a large increase in the amount of coastal area unavailable for leasing, and this added protection would lessen the potential impact of coastal development on the species.

Pacific Walrus

Alternative B-1 would make approximately 11 million acres of federally owned subsurface (about 48 percent of the total) of the NPR-A available for oil and gas leasing. About 11.8 million acres would be unavailable for leasing, including portions of two Special Areas that would be of particular benefit to walrus, a new Peard Bay Special Area and the enlarged Kasegaluk Lagoon Special Area. Under Alternative B-1, lease Stipulation K-6 (special restriction on facility development within three-quarters of a mile of the coast) would apply to all NPR-A Chukchi Sea coastal areas (except in the case of developing existing valid NPR-A oil and gas leases).

Under Alternative B-1, the effects of most non-oil and gas activities on walrus would largely be avoided, although adverse impacts could be experienced due to aircraft and vessel activity too close to haulouts. Walrus would continue to be more profoundly affected by climate change.

4.4.11.5 Potential New Mitigation Measure

Potential Mitigation Measure 1—Surveys for Sensitive Plant Species (new best management practice)

The objective and requirement/standard would be the same as those described in section 4.3.11.5 for Potential Mitigation Measure 1—Surveys for Sensitive Plant Species. The potential benefits and residual/unavoidable impacts would be similar to those described for Alternative A at section 4.3.11.5.

Potential Mitigation Measure 2—Surveys for Sensitive Terrestrial Mammals (new best management practice)

The objective and requirement/standard would be the same as those described in section 4.3.11.5 for Potential Mitigation Measure 2—Surveys for Sensitive Mammals. The potential benefits and residual/unavoidable impacts would be similar to those described for Alternative A at section 4.3.11.5.

Potential Mitigation Measure 3—Aircraft Avoidance of Walrus Aggregations (addition to Best Management Practice F-1)

The objective and requirement/standard would be the same as those described in section 4.3.11.5 for Potential Mitigation Measure 3— Aircraft Avoidance of Walrus Aggregations. The potential benefits and residual/unavoidable impacts would be similar to those described for Alternative A at section 4.3.11.5.

Potential Mitigation Measure 4—Marine Vessels Avoidance of Walrus Aggregations (K-6 Stipulation-Coastal Area)

The objective and requirement/standard would be the same as those described in section 4.3.11.5 for Potential Mitigation Measure 4—Marine Vessels Avoidance of Walrus Aggregations. The potential benefits and residual/unavoidable impacts would be similar to those described for Alternative A at section 4.3.11.5.

Potential Mitigation Measure 5—Vessel Operation (Addition to H-1 Best Management Practice)

The objective and requirement/standard would be the same as those described in section 4.3.11.5 for Potential Mitigation Measure 5—Vessel Operation. The potential benefits and residual/unavoidable impacts would be similar to those described for Alternative A at section 4.3.11.5.

4.4.12 Cultural Resources

4.4.12.1 Activities Not Associated with Oil and Gas Exploration and Development

Under Alternative B-1, the types of non-oil and gas activities would be the same as those described for Alternative A (see section 4.3.12.1), and the potential impacts to cultural resources would also be similar.

4.4.12.2 Oil and Gas Exploration and Development Activities

Effects of Seismic Surveys

Under Alternative B-1, the level of seismic activity could increase slightly over that of Alternative A (see section 4.3.12.2) in regards to 3-D activities. It is anticipated that there could be an increase of as much as 4,456 survey or camp train miles, about 8 percent, and 43,345 surveying and camp train acres, also about an 8 percent increase. However, given the low probability of impact from seismic activity, this is not regarded as a meaningful increase in terms of potential impact to cultural resources. Therefore, the probability of encountering and impacting scientifically significant cultural material under Alternative B-1 remains low.

Effects of Short-term Disturbance: Exploration and Delineation Drilling

Short-term impact-producing activities include drill pads, roads, and airstrips constructed of ice and snow totaling 233,478 acres. Under Alternative B-1, all of these activities are reduced by about 29 percent, compared to Alternative A (see section 4.3.12.2). Under Alternative A, the potential adverse impact to cultural resources from short-term disturbance is considered to be low. Under Alternative B-1, where less land is available for leasing and exploration, the amount of potentially impacting activities is substantially reduced and the potential for adverse impact remains low.

Effects of Long-term Disturbance: Development of Oil and Gas Infrastructure

Under Alternative B-1 the amount of potential disturbance from construction of central processing facilities and associated satellite pads, roads, airstrips, pump or compressor stations, and gravel pits in regard to surface area is reduced by about 2,400 acres, about 24 percent, and a reduction of about 10 million cubic yards, about 25percent of gravel mined, compared to that of Alternative A. Also by comparison, the number of pipeline miles (605) and potential vertical support members is reduced to 49,005, about 26 percent less than Alternative A. Meanwhile, while gas pipeline trenching increases by 57 miles, about 9 percent, adding 228,000 cubic yards to the total of excavated material and 104 acres (excavation plus spoil area) to the impacted surface or near-surface area. However, overall, the surface or near-surface area potentially impacted is significantly reduced under Alternative B-1.

Effects of Oil Spills and Gas Releases

Under Alternative B-1, the effects of spills on cultural resources would be no different from that discussed under Alternative A. However, since there would be fewer wells drilled and less infrastructure developed under Alternative B-1, the probability of encountering and impacting cultural material is reduced. As previously described (see section 4.3.12.2), there would probably be no adverse effect on cultural resources from a gas release.

Effects of Abandonment and Reclamation

As previously described (see section 4.3.12.2), abandonment and reclamation of short-term and long-term infrastructure, under most circumstances, would have limited, if any, impact on cultural resources.

4.4.12.3 Effectiveness of Stipulations and Best Management Practice

Under Alternative B-1, the primary safeguard for cultural resources is Best Management Practice E-13, which states that lessees will conduct a cultural resources survey prior to engaging in any potential ground-disturbing activity. There are other regulations, laws, and procedures, which also provide protections for cultural resources (see 4.3.12.3).

4.4.12.4 Conclusion

The primary potential impact to cultural resources would result from the surface or near-surface disturbance resulting from excavation of gravel, the laying down of gravel on the tundra for construction of the permanent facilities, and trenching. However, surveys for cultural resources are required to be conducted before excavation or any potential ground-disturbing activities could take place. Overall, given the effectiveness of the protections for, and the baseline data from past inventories and research regarding where cultural sites are most likely to occur, both non-oil and gas and oil and gas-related activities within the NPR-A have a very low probability of adversely impacting cultural resources. The potential effect of climate change is the same as described for Alternative A.

4.4.13 Subsistence

4.4.13.1 Activities Not Associated with Oil and Gas Exploration and Development

Under Alternative B-1, non-oil and gas-related activities requiring permits from the Authorized Officer would be subject to the protective measures outlined in Chapter 2 as well as any other applicable federal, State, and North Slope Borough regulations. Activities not associated with oil and gas exploration and development include aircraft and watercraft use, research activities (including remote camps associated with research), overland moves, and recreation. All of these activities have the potential to affect subsistence use. Refer to section 4.2.1 for a detailed description of the types of non-oil and gas activities that may occur in the NPR-A.

Effects of Disturbance

Aircraft Use

Under Alternative B-1, the effects of aircraft use on subsistence would be the same as those described under Alternative A (section 4.3.13.1). Aircraft could divert migrating or insect-avoiding caribou, as well as seals, walrus, and whales from subsistence use areas. Subsistence users have repeatedly stated during scoping meetings that aircraft traffic reduces harvest access and success (Nukapigak 1998; Ahtuanguruak 2003; Kaigelak 2003; Olemaun 2003). Disrupted harvests directly impact hunters in terms of lost time, effort, and resources (primarily fuel). Subsistence harvesters also describe the stress that occurs when they are out hunting, hear a helicopter operating nearby, and worry that the helicopter will approach and disrupt the hunt.

Watercraft Use

Under Alternative B-1, the effects of watercraft on subsistence harvest would be the same as those discussed under Alternative A (section 4.3.13.1): localized and temporary, possibly causing subsistence species to avoid the area of activity. The low level of watercraft use is not anticipated to significantly disrupt subsistence harvesters.

Research Activities

It is likely that scientific research and data collection that is related to climate change and endangered species will continue to increase regardless of lease sales. The effects of research activities would be similar to those described under Alternative A: possible temporary and localized diversions or disturbances of subsistence species. Research activities would primarily take place in the summer months and aircraft-based research would have the greatest likelihood of affecting subsistence harvest patterns.

Recreation and Film Permits

Recreational uses of the NPR-A include hiking, rafting, canoeing, wildlife viewing and bird-watching tours that are primarily conducted by commercial guiding companies. Six to 12 permits for recreation can be anticipated per year. Under Alternative B-1, more recreation could occur in the NPR-A in response to increased public awareness of expanded special areas and Wild and Scenic River designations. Recreation would likely be limited to summer use of river corridors. The effects would be similar to those under Alternative A: recreation could disturb the movements and habitat use of subsistence species, causing a short-term, localized effect. Recreational users would likely frequent waterways shared with other users, such as subsistence hunters, potentially resulting in resource user conflicts. If Alternative B-1 leads to a significant increase in recreation, there could be increases in user conflicts and greater effect to subsistence resources along highly utilized river corridors such as the Colville and the Utukok. The effects of these conflicts on subsistence harvest patterns would likely be localized and of short duration. As described under Alternative A, effects on subsistence species and harvest patterns caused by guided hunters in the NPR-A would usually occur outside the core subsistence use areas of NPR-A communities and would be localized and temporary.

Solid and Hazardous Waste Removal and Remediation

Solid and hazardous waste removal and remediation, including the monitoring of existing clean-up sites and aging infrastructure (e.g., wellheads) would occur under Alternative B-1 in the same manner as described in section 4.3.13.1 for Alternative A. These activities would involve site characterizations, transportation of equipment over ice roads or snow trails or barge, removal of hazardous materials, possible stockpiling of contaminated materials, and eventual disposal in an appropriate facility. Effects of waste removal and remediation under Alternative B-1 would be the same as described for Alternative A: helicopter use, ice roads, and snow trails could cause temporary and localized displacement of resources, and barging presents risks to sea mammal and bowhead whale hunting. Short-term effects could include a "plume" created by clean-up activities and an increased potential for contamination of subsistence species, particularly fish, in areas around the cleanup site. Long-term effects could include a decreased potential for contamination of subsistence species. Effects on subsistence harvest patterns by this activity would be localized and temporary, although many contaminated sites are located near NPR-A communities and can therefore affect nearby resources such as fishing areas.

Overland Moves

Overland moves, such as supply trips to communities via Rolligon in the winter on frozen tundra, would occur only by permit and would be subject to the regulations outlined in Chapter 2. The effects of overland moves under Alternative B-1 would be similar to those described for Alternative A: caribou, grizzly bears, polar bears, muskoxen, wolves, and wolverines could be displaced from the immediate area of the travel route, but the effects would be localized and would vary depending on the intensity and frequency of traffic.

4.4.13.2 Oil and Gas Exploration and Development Activities

Effects of Disturbances

Seismic Activities

The effects of seismic activity under Alternative B-1 would be similar to those described under Alternative A (see section 4.3.13.2), namely, displacement of game and disturbance of subsistence activities that can lead to loss of subsistence food; loss of time; loss of money; increased stress and anxiety; increased risk of equipment failure; and increased risk of loss of life or serious bodily injury. Given that there are no current proposals for seismic, the risk of these impacts occurring would be greater under Alternative B-1 than in Alternative A because there would be approximately 8 percent more acres that could be surveyed under this alternative. This small increase would most likely be felt by subsistence users of lands south of Wainwright that would be available for leasing under this alternative, but which would not be available under Alternative A.

Exploratory Drilling

The types of impacts from exploratory and delineation oil and gas drilling under Alternative B-1 will be identical to those described under Alternative A in section 4.3.13.2. Direct impacts to subsistence users and resources from an drilling operation would include displacement of resources away from the drill site; possible impacts to overwintering fish from water withdrawals, river crossings, and fuel spills near ice airstrips; and increased time, effort, and expense during hunting. Ice roads and/or packed snow trails are customarily used by local residents during the winter, both by snowmobile and truck/car. The presence of these types of access may concentrate hunting efforts along the route(s). In addition, increased traffic by locals increases the likelihood that resources such as caribou will be displaced from the route.

Summer activities associated with exploratory drilling involving the use of helicopters for access would result in displacement of resources due to aircraft or watercraft use; impacts to hunters from disrupted hunts; and possible increase in the amount of time, effort, and fuel needed to harvest displaced animals.

Given that exploratory and delineation drilling would be reduced by approximately 35 percent in Alternative B-1 compared with Alternative A, the effects on subsistence use would be reduced. The reduced impacts would likely be most beneficial for subsistence users of lands around Teshekpuk Lake or those who are dependent upon the Teshekpuk Lake Caribou Herd and other subsistence foods from that area because of the large area centered on Teshekpuk Lake that would not be available for future leasing.

Development and Permanent Facilities

The types of impacts from development and permanent facilities under Alternative B-1 would be identical to those that are described under Alternative A. Subsistence hunters would likely avoid development areas, resulting in a shifting of subsistence use areas away from permanent facilities, including pipelines and roads. Industrial activities could displace subsistence species from traditional harvest areas. Both winter and summer oil and gas activities could result in changes to nesting and molting habitat that affect waterfowl's use of the Reserve. Fish and fish habitats could be affected by water withdrawals, gravel mines, changes to hydrologic regimes due to infrastructure (e.g., pads, roads, causeways, docks, bridges and culverts), increases in turbidity and salinity, oil and hazardous materials spills, and access to new habitats. These activities have the potential to reduce fish populations, divert fish from their normal locations, kill large numbers of fish, or contaminate fish populations and habitat.

Subsistence hunters from all NPR-A communities could be affected by air traffic spooking caribou and other game, thus reducing harvest success and creating uncertainty and stress among subsistence hunters.

Generally, the smaller oil and gas development projected for Alternative B-1 compared to Alternative A would make it less impactful of subsistence. Yet there are subtle differences among North Slope communities on how oil and gas development under Alternative B-1 would impact subsistence.

- **Point Lay:** Alternative B-1 would provide important protections for Point Lay's subsistence use area: The Kasegaluk Lagoon Special Area would be 77 percent larger than it would be under Alternative A, there would be no leasing or non-subsistence permanent infrastructure allowed in the upper portion of the Kasegaluk Lagoon (that portion located within the NPR-A) and 1 mile inland. Point Lay subsistence use of the lower Kokolik and Utukok Rivers in NPR-A, areas extensively used by those villagers to travel, hunt, and fish could be more impacted under Alternative B-1, which makes those lands available for leasing, than under Alternative A. In spite of this difference and in part because coastal areas and the subsistence harvest of beluga whales and other resources in the Kasegaluk Lagoon are of vital importance to Point Lay, Alternative B-1 would provide overall greater protections than Alternative A.

- **Wainwright:** Wainwright's nearby coastal waterbodies (Peard Bay, the Kasegaluk Lagoon, Wainwright Inlet, and the lower section of the Kuk River) would be unavailable for leasing. No exploratory drilling or non-subsistence permanent infrastructure would be allowed in the Kasegaluk Lagoon or Peard Bay, including islands and one mile inland. A subsurface pipeline could be permitted in the Wainwright Inlet/Kuk River. Alternative B-1's provision for a 1.6-million-acre Peard Bay Special Area would provide extra protections from any oil and gas activity in important subsistence areas east of Wainwright and Alternative B-1's enlargement of the Kasegaluk Lagoon Special Area would provide a high standard of protection to a large traditional subsistence use area southwest of Wainwright. However, some lands south of Wainwright would be available for leasing and development under Alternative B-1 that would not be available under Alternative A, thus potentially impacting some terrestrial subsistence. Nonetheless, the greater protections for subsistence resources to the east, north, and west of Wainwright would result in Alternative B-1 impacting Wainwright subsistence less than Alternative A.
- **Atqasuk:** The Peard Bay Special Area would surround the community of Atqasuk to the north and west and would provide greater protection for Atqasuk's subsistence resources and activities than Alternative A, which does not include a Peard Bay Special Area. The most important coastal waterbodies for Atqasuk are Admiralty Bay and Dease Inlet, which would be unavailable for leasing, exploratory drilling, and new non-subsistence permanent infrastructure under Alternative B-1. Atqasuk also depends on the Teshekpuk Lake Caribou Herd, whose core calving and insect relieve habitat would not be available for leasing under Alternative B-1, while it is available under Alternative A.
- **Barrow:** Alternative B-1 would protect more of Barrow residents' subsistence harvest areas than Alternative A because nearby coastal waterbodies (Elson Lagoon, Dease Inlet, and Admiralty Bay) would be unavailable for leasing and new non-subsistence infrastructure. Moreover, Barrow residents fish during caribou harvest activities along the coast and in the Teshekpuk Lake and Chipp and Ikpikpuk rivers areas. The lower sections of both the Chipp and Ikpikpuk rivers would be unavailable for leasing, as would much of the lower section of the Topagaruk River, which is also important to subsistence users from Barrow. Several Barrow families have traditional subsistence camps at Peard Bay, an area that would be better protected under Alternative B-1 due to designation of the Peard Bay Special Area and the fact that the bay itself as a coastal waterbody would be unavailable for leasing and new non-subsistence infrastructure.
- **Nuiqsut:** Nuiqsut's primary harvest area for fish is located in the northeast corner of the NPR-A, in the Colville River and its delta channels and near Fish and Judy creeks. A loss or reduction in fish harvest would be a hardship for Nuiqsut since fish provide approximately 30 to 40 percent of the community's subsistence harvest by

weight. Both creeks are protected by setbacks on BLM land and, under Alternative B-1, Fish Creek would be largely unavailable for leasing. Nuiqsut residents would also benefit from this alternative making all of the Teshekpuk Lake Caribou Herd's core calving and insect relief area and important waterfowl habitat in the Teshekpuk Lake area unavailable. Finally, Alternative B-1 would also preclude leasing in the Kogru River, an important coastal waterbody that is within Nuiqsut's subsistence use area.

Effects of Abandonment and Reclamation

Oil facility abandonment and reclamation activities include the removal of all equipment and facilities and the plugging of all wells. During these activities, subsistence resources and activities would be subject to impacts similar to those caused by construction as described under Alternative A (see section 4.3.13.2). Following the abandonment and reclamation, subsistence resources would be subject to fewer impacts. If the gravel roads and pads were left in place and remained serviceable, they could be used by residents to access subsistence resources, possibly reducing hunting effort and time.

Effects of Oil Spills

The types of effects of oil spills on subsistence resources under Alternative B-1 are identical to those described for Alternative A in section 4.3.13.2. Impacts would depend on the size and location of the spill: those on pads are less likely to have impacts, those on the tundra could affect small numbers of terrestrial mammals, and those that directly enter a waterbody could spread widely and be toxic to fish and waterfowl, leading to long-term, population level effects. Subsistence harvesters would likely not take caribou or other consumable resources from the general area. As described for Alternative A, the Iñupiat consider contamination from oil spills in nearshore waters to be a catastrophic possibility that would threaten their very existence (Brower 1976; Itta 2001). Impacts could include injury or death to bowhead whales and other marine mammals or a shift in the migration routes of these species. The loss of an important source of subsistence food would result in financial hardship and increased pressure on terrestrial subsistence resources. Such an event could also trigger a reduction in the International Whaling Commission subsistence bowhead whale quota, which would cause hardship for all subsistence whaling communities in Alaska, Canada's Arctic, and Chukotka.

Although the types of impacts of oil spills would be identical under all alternatives, the number of small spills and the chance of a large spill that would affect subsistence species would be least under Alternative B-1. Also, the fact that nearshore environments in the NPR-A would be unavailable for leasing under Alternative B-1 reduces the risk of spills in these particularly critical environments.

4.4.13.3 Effectiveness of Stipulations and Best Management Practices

Many of the protective measures outlined in Alternative B-1 are intended to ensure the continued health of subsistence resources and to promote a responsive relationship between subsistence users, the BLM, and oil and gas companies.

Alternative B-1 provides important measures that are explicitly aimed at minimizing conflicts between subsistence users and other activities. H-1 is designed to prevent unreasonable conflicts by requiring that a prospective lessee/permittee consult directly with affected communities to discuss the timing, location, and methods of their proposed operations. An applicant must document its consultation efforts as part of its plan of operation and must submit the plan of operations to the National Petroleum Reserve in Alaska Subsistence Advisory Panel for review and comment. An applicant must submit said plan sufficiently early to provide time for review by the Subsistence Advisory Panel and, if necessary, for Government-to-Government consultation with Native Tribal governments. Among other items, the operations plan must describe methods the applicant will use to monitor the effects of the activity on subsistence and must describe how the applicant will keep potentially affected individuals and communities up-to-date on the activities and locations of possible conflicts with subsistence users. Whereas the objective of Required Operating Procedure H-1 under Alternative A is focused on oil and gas activities, the objective of Best Management Practice H-1 under Alternative B-1 is expanded to reflect the fact that research and other events can also disturb subsistence areas and users.

In addition to the consultation process detailed in H-1, Best Management Practice H-2 is intended to prevent unreasonable conflicts between subsistence activities and seismic exploration by mandating that an applicant for seismic exploration shall notify local Search and Rescue operations of current and recent seismic surveys and shall notify in writing all potentially affected cabin and camp users.

Effectiveness of Stipulations and Required Operating Procedures/Best Management Practices on Subsistence Species

Many of the protective measures outlined in Alternative B-1 are intended to minimize the surface impacts of oil and gas activities and to otherwise ensure the continued health of wildlife and subsistence resources. For complete descriptions of the measures under Alternative B-1 that are designed to mitigate impacts to fish, birds, terrestrial mammals, and marine mammals, please refer to those resource sections. Although Alternative A has many similar measures designed to protect subsistence species in particularly sensitive areas, many of these species and areas would be more effectively protected under Alternative B-1 because the areas would not be available for leasing, and corresponding measures under Alternative B-1 would apply to existing leases. Measures that are particularly relevant to subsistence species are listed below and specific differences that would make the measures more or less effective under Alternative B-1 are noted.

- A-4 minimizes the impacts of contaminants on fish, wildlife, and the environment, and A-11 would mandate, for all permanent development, the design and implementation of a study to monitor contaminants in subsistence foods.
- Measures that minimize disruption of caribou include E-7, K-9, K-10, and K-12. E-7, which regulates the characteristics of pipelines, would be more effective under Alternative B-1 because it includes an additional requirement that all aboveground pipelines would have a non-reflective finish. K-12 protects habitat of the Western Arctic Caribou Herd and has no comparable provision under Alternative A.
- K-6 is a measure that minimizes hindrance of caribou movement within caribou coastal insect-relief areas and its objective, under Alternative B-1, has been expanded to protect the summer shoreline habitat for polar bears, walrus, and seals.

- To protect fish habitat, B-1 and B-2 regulate water withdrawals, K-1 establishes setbacks along rivers, and C-2 to C-4 protect streams and prevent additional freeze down of deep-water pools. K-1 would be more effective under Alternative B-1 than under Alternative A because larger setbacks are provided for portions of the Colville, Ikpikpuk, Kikiakrorak, Kogosukruk, and Titalik rivers.
- K-3 minimizes disruptions to the natural qualities and functions of the Teshekpuk Lake Shoreline.
- K-3b sets significantly higher standards for oil and gas activities in major coastal waterbodies.
- K-8b protects subsistence resources and activities in the Kasegaluk Lagoon Special Area.
- E-10 minimizes the chances that migrating waterfowl will strike oil and gas facilities during low light conditions.

Unlike Alternative A, Alternative B-1 includes a provision (Best Management Practice H-3) that minimizes impacts to important subsistence species by prohibiting employees of the oil and gas industry or other permitted activities to hunt or trap while working. This measure addresses a key concern of subsistence hunters, which is the encroachment of outside hunters and any resulting competition for resources.

Effectiveness of Stipulations and Best Management Practices on Subsistence Harvest Patterns

In general, best management practices and lease stipulations seek to protect specific resources by establishing spatial buffer zones around facilities and infrastructure, scheduling disruptive activities when there is the least potential for conflicts with other users, making efforts to include community residents in project planning, monitoring effects on subsistence resources, and making efforts to minimize the interference of oil and gas exploration and development activities and structures with subsistence resources and users. For example, I-1 is a measure that minimizes conflicts with subsistence users by requiring orientation programs for oil and gas company employees. These programs include information on location-specific environmental, cultural, and social concerns as well as information about subsistence activities and the potential of aircraft use to disturb subsistence users.

Aircraft use near traditional subsistence cabins and campsites during spring goose and fall caribou and moose hunting is a particularly common concern. By mandating minimum flight altitudes, Best Management Practice F-1 mitigates the effects of low-flying aircraft on wildlife. This is effective when practicable and when obeyed, however, it is difficult to enforce and, as mentioned above, there are three major exemptions: wildlife surveys, foul weather, and take offs and landings. Furthermore, the BLM has no authority over private aircraft or aircraft used by projects that do not have BLM permits. BLM-chartered aircraft and aircraft use by BLM permittees account for a small percentage of the aircraft use in the NPR-A; therefore, the BLM is not able to effectively mitigate the wider problem. The BLM has implemented a system whereby subsistence users notify the BLM of problem aircraft and the BLM attempts to track down the pilots or owners of the aircraft. Nevertheless, aircraft interference with subsistence activities continues to be a primary impact of oil and gas and other activities in the NPR-A. Several residents of Nuiqsut contend that the nuisance caused by aircraft is at such a high level that they no longer support roadless development, which was previously the preferred option. According to these residents, roads and road traffic through town would have many advantages and disadvantages, but on the whole would be preferable to the high number of overflights that the community currently experiences (USDOI BLM 2010).

Several measures provide specific limitations on development near subsistence sites. Lease Stipulations K-1, K-2, and K-3 would minimize impacts to subsistence cabins and campsites and disruptions to subsistence activities by prohibiting permanent oil and gas facilities (e.g., gravel pads, roads and airstrips, and pipelines) through setbacks areas around rivers, lakes, and coastal waterbodies. Lease Stipulation K-6 is intended to minimize impacts to subsistence activities from permanent oil and facilities in coastal areas by implementing, to the extent practicable, a setback of three quarters of a mile from the coastline and by mandating the use of previously occupied sites (e.g., Camp Lonely, various Husky/USGS drill sites, and Distant Early Warning-Line sites) when possible. Other measures that are particularly relevant to subsistence harvest patterns include:

- E-1, which requires that all roads be designed to protect subsistence use and access to traditional hunting and fishing areas.
- E-2, E-3, E-6, and E-8, which maintain subsistence use and access to traditional subsistence fishing sites.
- E-7, which mandates pipeline height to provide for the safe and unimpeded passage of subsistence hunters.
- K-8b is the measure that regulates the Kasegaluk Lagoon Special Area, the objective of which is in part to protect traditional subsistence uses and public access to and through Kasegaluk Lagoon for current and future generations of North Slope residents. Because Alternative B-1 precludes leasing in the entire Kasegaluk Lagoon Special Area, protection is provided at a higher level than in Alternative A.

The actual effectiveness of protective measures depends heavily on their ongoing implementation, on enforcement, and on the precise location of facilities and infrastructure. Effectiveness is also dependent on the sharing of local knowledge and on informed input from residents of affected communities. As described above, several measures are designed to ensure that subsistence hunters participate in plan design. However, municipal governments and tribal governments generally have limited funding and few paid staff, and members of these organizations feel overtaxed when asked to provide meaningful input to the BLM on proposed or permitted activities. This institutional overload affects subsistence users by placing increased, non-compensated demands on their time, further reducing the time available for subsistence pursuits. Many such NPR-A residents contend that the change from the prescriptive lease stipulations that were put in place by the 1998 Northeast IAP/EIS to the performance-based rules put in place by subsequent IAP/EISs forces them to spend more time defending subsistence interests because compliance is now defined in terms of meeting management objectives rather than adhering to absolute standards. The contention that it now takes more time to review and to effectively respond to industry proposals was reiterated during scoping meetings in 2010 (USDOI BLM 2010).

The BLM has found that performance-based regulations provide equal protection with greater flexibility and project relevance. The flexibility of the performance-based approach places greater reliance on on-going monitoring to ensure that regulations are in fact achieving the desired level of protection. The BLM is committed to directing the resources necessary for on-going monitoring, including support for the Subsistence Advisory Panel to provide oversight, exchange information, and develop solutions for emerging issues.

4.4.13.4 Conclusion

The effects of non-oil and gas activities on subsistence species under Alternative B-1 would be similar to those that would occur under Alternative A. There could be less exploration and development-related scientific research under Alternative B-1 than under the other alternatives because leasing and non-subsistence permanent infrastructure would be prohibited in many critical subsistence resource and use areas. The impact of non-oil and gas activities is greatly dependent on the time and precise location of said activities. Activities would be, in most cases, of limited duration and magnitude, and effects on subsistence would be limited to the immediate area of the activity.

Primary impacts could include the avoidance of traditionally used subsistence areas due to development and aircraft use as well as anxiety over this loss; the deflection of caribou and other important subsistence resources from areas of activity; increased difficulty harvesting caribou and other subsistence resources; the necessity to make longer and more distant trips in order to have a successful harvest, and the increased cost, risk, and time commitment this entails. The effects of disturbance from permanent oil and gas facilities on terrestrial mammals during the production phase would be of relatively long duration, but would be local in nature. However, decreased opportunities to harvest terrestrial mammals could be especially problematic if climate change inhibits fall travel by delaying freeze up or causes subsistence species to shift their migration routes or schedules. If climate change causes Arctic Ocean ice to retreat farther from the shore, it will make the harvesting of whales and other marine mammals more difficult, which could in turn increase pressure to harvest terrestrial subsistence foods. Under Alternative B-1, both winter and summer oil and gas activities could result in changes to nesting and molting habitat that affect waterfowl's use of the Reserve. Fish and fish habitats could be affected by development activities that could potentially reduce fish populations, divert fish from their normal locations, kill large numbers of fish, or contaminate fish populations and habitat.

Subsistence activities in all NPR-A communities could be directly affected by development activities under Alternative B-1. However, Alternative B-1 emphasizes the protection of surface resources and it is likely that fewer acres would be disturbed overall by oil and gas activities than under Alternative A or the other alternatives. Please refer to the analysis of Alternative B-2 for a more detailed analysis of its particular impacts and comparison to Alternative B-1. By enlarging three special areas, creating one new special area, and making leasing and non-subsistence permanent infrastructure unavailable in coastal waterbodies, in the Utukok River Uplands Special Area, and in much of a greatly enlarged Teshekpuk Lake Special Area, Alternative B-1 provides significantly more security for key subsistence species and use areas than Alternatives A, B-2, C, or D. In particular, the risk of direct and indirect impacts to the subsistence use areas of Nuiqsut, Barrow, Point Lay, and Atqasuk, is reduced under Alternative B-1.

4.4.14 Sociocultural Systems

Please refer to section 3.4.4, "Sociocultural Systems" in Volume 1 for background information on cultural values, social organization, and social health in the NPR-A's Iñupiaq communities.

4.4.14.1 Activities Not Associated With Oil and Gas Exploration and Development

Under Alternative B-1, the effects of non-oil and gas activities on sociocultural patterns would be the same as under Alternative A. Please refer to section 4.3.14.1 for a more inclusive analysis of the impacts of non-oil and gas activities on Iñupiaq sociocultural systems. The amount of research related to climate change and endangered species is likely to increase regardless of development scenarios. These research efforts and associated aircraft use could cause temporary and localized diversion or deflection of subsistence species for as long as the studies were underway. Alternative B-1 could result in an increase in recreation in the NPR-A and a corresponding increase in the number of user conflicts, particularly along rivers that are recommended for Wild and Scenic River designation and are also important for subsistence, such as the Colville. It is not expected that the amount of soil and hazardous waste removal would be greater under Alternative B-1 than under the other alternatives or that the number of overland moves would change significantly. In general, effects from non-oil and gas activities under Alternative B-1 would be temporary and localized, and would be unlikely to affect overall sociocultural patterns.

4.4.14.2 Oil and Gas Exploration and Development Activities

Oil and gas exploration, development, and production would require a seasonal network of snow and ice roads and a permanent network of production facilities, pipelines, power lines, and gravel roads, runways, and pads in the NPR-A. The percentage of this network associated with gas could be higher under Alternative B-1 than under Alternative A and gas exploration and development activities would likely impact NPR-A communities that are currently less accustomed to development. The overall extent of industrial development in the NPR-A would be less under Alternative B-1 than under the other alternatives. By making much of an expanded Teshekpuk Lake Special Area unavailable for leasing and non-subsistence permanent infrastructure, Alternative B-1 is particularly significant for the resilience of Iñupiaq sociocultural systems. As stated above, this area is highly utilized for subsistence purposes, and continued use of the land results in several positive cultural values including the transfer of knowledge between elders and youth related to those areas; the integrity of culturally important places; and the importance of hard work, cooperation, and sharing.

Effects of Disturbances

The types of effects on sociocultural patterns from disturbances caused by oil and gas activities under Alternative B-1 would be the same as under Alternative A, but would be reduced in intensity and duration. Decreases in the area available for leasing and exploration would correspond to a decrease in effects to subsistence harvests as compared to those for Alternative A. The development proposed for the NPR-A under Alternative B-1 would result in less staging and overland travel during the winter and in summer would result in decreased use of aircraft for supplies, equipment, and crew changes, as compared to the other alternatives. In all seasons, noise, lights, personnel, and traffic near the anticipated oil and gas infrastructure could temporarily deflect or divert caribou in areas where activities are occurring.

Gravel pads or roads could provide caribou with insect-relief habitat, but these effects could change the distribution, timing, and location of the caribou harvest. Subsistence hunters could be diverted from oil and gas facilities at distances from 5 to more than 25 miles as a result of their desire to harvest away from production facilities, which could require increased effort and expenditure on the part of subsistence hunters. Given the high gasoline costs on the North Slope, this would add additional cost to subsistence harvests. Increased fuel costs and wear and tear on hunters and their equipment could increase the need for search and rescue missions and could increase the need for wage labor to support subsistence pursuits. This would reduce the time available to pursue subsistence activities, which would result in sociocultural consequences such as increased stress and a decreased sense of well-being. These problems are discussed in more detail in Chapter 4, Alternative B-1, in the "Public Health" section. Increases in the speed, range, and reliability of outboards and snowmobiles have facilitated the mixed subsistence and wage economy, but could not compensate for impacts to subsistence harvest activities from continued development and production activities in important subsistence harvest areas. Under Alternative B-1, these impacts would likely be experienced less frequently by residents of Nuiqsut, Barrow, and Atqasuk who utilize the Teshekpuk Lake area because of the prohibition of new leases in that area and there would be fewer incidences of competition/overlapping subsistence use areas between these communities. However, these impacts may be experienced more frequently by residents of Wainwright and Point Lay if oil and gas activities increase in those communities' subsistence use areas that are available for leasing under Alternative B-1.

As discussed under Alternative A, long-term change to sociocultural patterns would result from a weakening, through prolonged stress and disruptive effects, of traditional institutions that have stabilizing effects within the society. Activities occurring under this alternative would exacerbate those effects, but to a lesser extent than activities under the other alternatives. These changes are already occurring on the North Slope because of migration to urban areas, onshore and offshore oil and gas development, more dependence on a wage economy, higher levels of education, improved technology, improved housing and community facilities, improved infrastructure, increased presence of non-Alaska Natives, increased travel outside of the North Slope, and increasing penetration of television and the Internet. Data from other circumpolar Inuit populations suggest that continued modernization is associated with a trend toward displacement of sociocultural systems, including: a trend toward less time being spent conducting subsistence harvest activities; less subsistence consumption among younger generations; a greater focus on a cash-based economy, as opposed to the egalitarian sharing network; an increased importance on the nuclear family, as opposed to the more-traditional extended family structure (Curtis et al. 2005; Nobmann et al. 2005; Condon et al. 1995). North Slope Borough institutions, such as the school district that promotes the teaching of Iñupiaq language and culture, the Arctic Eskimo Whaling Commission that negotiates with industry to protect Iñupiaq subsistence whaling interests, the North Slope Borough Department of Wildlife Management, and other regional and village Native corporations and organizations have been working to prevent the weakening of traditional Iñupiaq cultural institutions and practices. A number of social impacts are associated with increased contact with outside groups; however there currently appears to be a high level of separation, acceptance, and indifference between residents and workers in NPR-A communities. Under all alternatives, it is estimated that an influx of oil and gas workers today would represent a negligible fraction of the overall impact from modernization and the global economy.

Effects of Abandonment and Reclamation

At present, very few NPR-A residents have jobs in the oil fields (Circumpolar Research Associates 2002). Abandonment and reclamation activities would likely generate jobs for local residents for several years and at greater levels of employment than would exist during the operational phase. If local residents were to become substantially integrated into oil field operations, their families could face economic difficulty as fields were abandoned. North Slope communities, due to the support of the North Slope Borough, are already dependent on revenues associated with oil development. If no oil fields were active in the area to provide jobs and contribute economically to the local economy and government revenue, the community would face a time of economic depression, which is associated with increased social pathology in Iñupiaq communities, as discussed in section 4.4.20. The Arctic Slope Regional Corporation dividends, which are less dependent on local resource development, could provide some mitigating financial support if oil and gas revenues decrease. However, no potential avenues for maintaining income at the standards established in the oil development era have been identified. Abandonment and reclamation activities would restore habitat for caribou and other subsistence species and subsistence resources would thereafter be subject to fewer impacts, potentially improving subsistence opportunities.

Effects of Oil Spills

Under Alternative B-1, the likelihood of a spill event with the potential to damage unique critical habitats and subsistence use areas is less than under the other alternatives. The effects of oil spills would be the same as those discussed in Alternative A: effects would vary in severity depending upon the timing and location of the spill event, but fish, waterfowl, and marine and terrestrial mammals could all be affected. An oil spill could result in contamination of subsistence resources and would be a threat to the health and lifestyle of the affected communities. If a large oil spill occurred in a traditional use area, then subsistence users would have to travel further to harvest uncontaminated resources, which could result in high effects to sociocultural patterns for a much longer time than the period that subsistence resources would be measurably contaminated. An oil spill that reached coastal waters could affect the harvest of marine mammals, including bowhead whale harvests, which are at the center of Iñupiaq sociocultural organization. The preclusion of leasing in nearshore coastal waterbodies under Alternative B-1 is a management action that significantly reduces the threat of an oil spill in these particularly important environments.

Activities associated with cleanup of an oil spill could have an effect on sociocultural systems. In the event that a large spill contacted and extensively oiled fish and wildlife habitats, the presence of hundreds of humans, boats, and aircraft would increase the displacement of subsistence species and alter or reduce access to subsistence species by subsistence hunters. These events would supply short-term employment for local residents, potentially at the expense of subsistence activities and subsistence resource availability.

Because it is expected that oil spills from authorized activities would be small events and would normally be contained on the drill pad, effects from the spills themselves and potential disruptions from clean-up activities would be unlikely to cause excessive disturbance to sociocultural systems or the surrounding environment. A large oil spill, however, would be catastrophic to the sociocultural structure of the whaling peoples of the North Slope if it were to occur in the riverine environment.

4.4.14.3 Effectiveness of Stipulations and Best Management Practices

The management actions proposed under Alternative B-1 would not allow oil and gas leasing in several culturally and environmentally important areas and would enlarge three Special Areas and create one new Special Area. In addition, the stipulations and protective measures that would be put in place by Alternative B-1 provide higher levels of protection along several rivers and in other sensitive areas. Because subsistence is an inherent component of cultural values, kinship, and social health, the description of the measures under Alternative B-1 that are relevant to subsistence species and subsistence access (section 4.4.13.3) is also applicable to this summary of sociocultural impacts. Best Management Practice H-1 provides opportunities to affected communities for participation in planning and decision making to prevent unreasonable conflicts between subsistence users and oil and gas related activities. This Best Management Practice would allow NPR-A residents to be more aware of science and research projects in their region and to suggest changes or additions to those projects so that Iñupiat sociocultural systems are better served by them.

Particularly relevant for sociocultural systems is Best Management Practice I-1, which would require the lessee to provide a cultural orientation program for all oil and gas personnel involved in NPR-A activities in order to effectively minimize cultural and resource conflicts with local inhabitants. This orientation program, as it relates to subsistence pursuits and cultural concerns, would: (1) provide sufficient detail to notify personnel of applicable lease stipulations and ROPs, as well as inform them about specific types of environmental, social, traditional, and cultural concerns that relate to the region; (2) address the importance of not disturbing archaeological and biological resources and habitats, and provide guidance on how to avoid disturbance; (3) be designed to increase sensitivity and understanding of personnel to community values, customs, and lifestyles in areas where personnel would be operating; (4) include information about avoidance of conflicts with subsistence, commercial fishing activities, and pertinent mitigation; and (5) include information for aircraft personnel concerning subsistence activities and areas and seasons that are particularly sensitive to disturbance by low flying aircraft (for example, aircraft use near traditional subsistence cabins and campsites, flights during spring goose hunting and fall moose hunting seasons, and flights near North Slope communities).

4.4.14.4 Conclusion

Alternative B-1 makes nearly 11 million acres of federally owned subsurface (48 percent of the total in NPR-A) immediately available for oil and gas leasing. This allows for development to sustain North Slope Borough revenues and thus for the important socioeconomic support the North Slope Borough provides in NPR-A communities. As described above, it does not alleviate the long-term issue of maintaining income at the standards established in the oil development era. Under Alternative B-1, many areas of importance to subsistence users, including areas surrounding subsistence camps, critical habitat for subsistence species, and large concentrations of historic and prehistoric cultural resources, would be protected from the impacts of oil and gas activities. For example, several families from Atqasuk, Barrow, and Nuiqsut use cabins, camps, caches, and other sites along the coast, inland to Teshekpuk Lake, and along the Chipp and Topagaruk rivers for subsistence activities. Use of these areas helps maintain family connections and a feeling of relatedness and stability, which could be secured by the prohibition of leasing. The protections that Alternative B-1 provides for Peard Bay and the Peard Bay Special Area would create similar securities for Barrow and Wainwright families that use that area. Wainwright families would experience similar benefits from the prohibition of leasing in Wainwright Inlet/Kuk River and the prohibition of leasing and permanent oil and gas infrastructure in Kasegaluk Lagoon. Those protections of the Kasegaluk Lagoon are of paramount importance to Point Lay subsistence users.

Impacts from oil and gas activities, although decreased under Alternative B-1 compared to the other alternatives, will continue to affect NPR-A communities and could increase overall. The communities of Point Lay and Wainwright are more likely to experience sociocultural impacts under Alternative B-1 as compared to Alternative A because leasing could occur in part of the southern NPR-A and areas near those communities are likely to see gas development. If marine traffic, including the barging of equipment to staging areas, increases in the near shore areas of the Beaufort and Chukchi seas, bowhead whales could be deflected or their behavior made more dangerous to hunters (North Slope Borough 2004). Increased traffic and activity could also make subsistence harvesting more difficult for residents who do not own or have access to motorized transportation or depend on walking, trucks, and off-highway vehicles to travel to harvest areas. Traffic around communities could isolate the community from subsistence resource harvest areas and could prevent residents from using their homelands, subsistence cabins and camps, and unspoiled open areas for resource harvests and pursuits. This would further degrade the quality of life and connection of people with their land and environment. In addition, should harvests decrease, resources would no longer be available in amounts suitable for sharing, resulting in changes in social organization and cultural values.

While federal subsistence management responsibilities would remain unchanged under all alternatives, many subsistence users in the NPR-A communities are doubtful about the consultation process and about the BLM's commitment to protecting subsistence and the subsistence culture. The BLM initiates consultation by informing interested parties of the proposed action, and inviting said parties to participate in consultation, the nature of which is to be determined by mutual agreement. If informed parties have no issues and do not wish to participate in further discussions, that is their choice and consultation may be complete, although the BLM will continue to communicate and inform those entities initially contacted for consultation throughout the planning process. Some NPR-A residents have expressed during the scoping meetings for this and previous NPR-A IAP/EISs that they are frustrated by the reoccurring demands put on them to review and provide relevant comments on IAP/EISs every few years and on each industry proposals as they arise. This does not build confidence on the part of the communities, and reinforces their feelings of being powerless to oppose changes being imposed by outside agencies and industry. As a result, some residents regard any effort to participate in consultation or other management processes as futile. This can create a feedback loop of decreased participation, decreased interest in cooperation with agencies, and increased conflict between agencies, lessees, and local resident groups as evidenced in scoping transcripts for over 30 years of hearings held on the North Slope. The management actions and protective measures that would be put in place by Alternative B-1 would alleviate this tension to a significant extent because no new leases would be allowed in the culturally important Teshekpuk Lake Special Area or nearshore environments. Alternative B-1 addresses community subsistence concerns to a greater degree than Alternatives A, B-1, C, and D and thus reduces social stress and other threats to Iñupiaq sociocultural systems.

4.4.15 Environmental Justice

4.4.15.1 Activities Not Associated With Oil and Gas Exploration and Development

The non-oil and gas activities likely to occur in the planning area would primarily be transitory in nature, of short duration, and highly localized. They could temporarily divert, deflect, or disturb subsistence species from their normal patterns. Non-oil and gas activities could alter the availability of subsistence species in traditional harvest areas, which could affect harvest patterns by requiring hunters to travel further in pursuit of resources. Increased travel distances would result in greater expenditures for fuel and equipment, and increased wear and tear on snowmobiles, outboards, and four-wheel vehicles and could result in a higher risk of accidents. Consequently, there could be an effect on the subsistence hunting activities of the local minority population as a result of non-oil and gas activities. Under Alternative B-1, these effects would be the same as those described under Alternative A: minor, temporary, short term, and generally highly localized. As outlined in section 4.4.21, this could result in isolated problems of social pathology.

4.4.15.2 Oil and Gas Exploration and Development Activities

Effects of Disturbance

Under Alternative B-1, disturbances caused by oil and gas activities would be the same as those discussed under Alternative A, but their effects on subsistence would be decreased in magnitude, extent, and duration. Several areas that are available for year-round occupation and development under Alternative A would be unavailable for lease and year-round surface occupation under Alternative B-1. Exploration and development activity could last 50 to 60 years, followed by 2 to 5 years of abandonment activity. This timeframe would likely represent the duration of effects for species unable to habituate to the oil and gas development activities. Public health effects relating to sociocultural and dietary change, as well as exposure to contaminants, could persist for considerably longer.

Alternative B-1 could have long-term effects on several terrestrial mammal species. Effects on caribou herds would likely be less than under Alternative A (see section 4.4.9, “Terrestrial Mammals”). Little or no effect on marine mammals would be expected from onshore activities under Alternative B-1, but noise and disturbance associated with offshore barge and vessel traffic could impact bowhead whale migration patterns. There are concerns that, depending on the particular activity and, especially, the location of the activity, actions occurring under Alternative B-1 could cause local effects on fish populations. All of these effects would be experienced primarily by the subsistence dependent minority Iñupiaq population.

Under Alternative B-1, the possibility of public health impacts would be decreased compared with Alternative A. Impacts would occur primarily through restrictions in subsistence; new access routes to the community; sociocultural and economic change; altered employment; and contaminants. Given that Alternative B-1 involves substantially less development in and near particularly sensitive habitat and hunting and fishing areas, the risk of dietary change and the resultant increases in metabolic disorders would appear to be significantly decreased. Food insecurity would likely decrease substantially, and hunger could decrease as well if substantial impacts on subsistence harvests are alleviated. Cancer, lung disease, endocrine disruption, and neurodevelopmental delay are related to contaminants common to oil and gas development. The risks of these problems would be decreased under Alternative B-1. Although social pathology could result from subsistence impacts and economic changes, it is estimated that stress and maladaptive coping will be less than would occur under Alternative A due to the wider regions of important traditional use areas that are protected.

Effects of Abandonment and Reclamation

Abandonment and reclamation activities would likely generate jobs for local residents for several years above the level that would exist during operations. Activities associated with dismantling and removing of production pads and facilities could disproportionately impact NPR-A residents through disturbance, displacement, and mortality of subsistence resources, through subsistence users' avoidance of areas undergoing dismantlement and removal, and through potential impacts to water, air quality, and noise. Once abandonment and reclamation were completed, NPR-A residents would be disproportionately impacted by the reduction in local and Native corporation revenues and by fewer local jobs and business opportunities. Since economic depression is associated with increased social pathology, this could result in increases in domestic violence, injury, drug and alcohol problems, and suicide. Local residents could benefit from a reduction in impacts on subsistence resources, compared to during construction and operation.

Effects of Oil Spills

As discussed elsewhere, the magnitude of effects of a crude oil spill on subsistence resources would depend on the context of the spill, the volume and area covered by spilled product, and the amount of time before clean-up efforts commenced. Tundra oil spills could affect small numbers of terrestrial mammals and waterfowl unable to avoid the spill area, but would be unlikely to have population level effects. Oil spills (any size) directly into a water body, particularly in difficult to contain conditions such as breakup or broken ice, could spread widely and have effects on fish and waterfowl. In the nearshore environment, a large to very large spill, particularly during broken ice or storm conditions, could affect marine mammals including seals, and beluga and bowhead whales. Oil spills can also be associated with toxicological health effects in human populations, as outlined in section 4.4.21. Furthermore, if a large spill resulted in a substantial decrease in consumption of subsistence foods, food insecurity and hunger as well as diabetes and related metabolic disorders could increase.

The Iñupiat consider contamination from oil spills in nearshore waters to be a catastrophic possibility that would threaten their very existence, primarily because of the potential effects of spills on bowhead whales, which are a very important part of their culture in addition to being a favored food source (Brower 1976; Itta 2001). Potential effects on subsistence harvest patterns would be less under Alternative B-1 than under Alternative A because oil and gas activity would potentially occur over a smaller area in the planning area than under Alternative A, and there would thus be less potential for oil spills. A major oil spill on the North Slope would result in effects that would impact Iñupiaq subsistence users more than any other human group.

4.4.15.3 Effectiveness of Stipulations and Best Management Practices

The lease stipulations and best management practices for Alternative B-1 would protect subsistence resources to a greater extent than the lease stipulations under Alternative A. Best Management Practices H-1 and H-2 would be highly effective in reducing conflicts between subsistence uses and oil and gas and other potentially disruptive activities.

4.4.15.4 Conclusion

Several lease sales have already taken place in the planning area and additional exploration programs and development are expected. The effects of these activities would continue under Alternative B-1, but would be significantly reduced as compared to Alternative A because of the prohibition of leasing in severally critically important subsistence and cultural areas. Most effects of disturbance would still be short term, but the extent and magnitude would likely decrease. Effects from oil spills would depend greatly on the size, location, and season of the spill. Small spills on gravel pads would have little or no environmental justice effects. A major spill into a watercourse, on the other hand, could have long-term serious effects on Iñupiaq subsistence activities. While any large spill would have serious consequences, the worst, from an environmental justice standpoint, would be one that occurred in a key harvest area or near a community. The risk of such a spill is greatly reduced by the prohibition of leasing and permanent oil and gas facilities in coastal waterbodies and the Teshekpuk Lake Special Area under Alternative B-1.

Although reduced as compared to the other alternatives, the activities likely under Alternative B-1 could have substantial health effects, as outlined above and discussed in detail in section 4.4.21. Because the population within and near the planning area is primarily comprised of Iñupiat, any health effects that occur would disproportionately affect this minority population.

4.4.16 Recreation Resources

Alternative B-1 would allow leases to be offered for oil and gas exploration and development on 48 percent of NPR-A subsurface lands. Another 1.57 million acres would remain deferred from oil and gas leasing until 2014; and 425,000 acres would be deferred until 2018. There are 15.5 million acres that would be recognized as special areas (Teshekpuk Lake Special Area, Colville River Special Area, Utukok River Uplands Special Area, Kasegaluk Lagoon Special Area, and Peard Bay Special Area). Alternative B-1 would recommend 12 rivers be designated as Wild and Scenic Rivers.

4.4.16.1 Activities Not Associated with Oil and Gas Exploration and Development

Under Alternative B-1, recreation resources could be affected in the same way as Alternative A from activities not associated with oil and gas exploration and development. Alternative B-1 emphasizes the protection of surface resources of the NPR-A and makes portions of the Reserve unavailable for leasing, neither of which would change the effects of activities not associated with oil and gas as compared to Alternative A.

4.4.16.2 Oil and Gas Exploration and Development Activities

Ice Roads, Ice pads, Airstrips and Snow trails

Ice roads, pads, airstrips and snow trails are temporary in nature and traversed during the winter months. Ice roads provide seasonal routes for heavy equipment supplies and movement of personnel to remote staging areas or well locations. Ice airstrips are used to transport crews and supplies to and from sites. Snow trails provide seasonal routes for use by low-ground pressure vehicles and used for moving equipment, supplies, personnel accommodations, and drill rigs capable of disassembly into components small enough for transport on such vehicles. Under Alternative B-1, the estimated total seasonal acres impacted by ice roads, ice pads, airstrips and snow trails is 232,710 acres or 77,570 miles. Activities in the winter would be far less visible due to the limited daylight hours. Due to the remoteness and climate of the Reserve, and typical type and frequency of recreation use taking place in the winter, there would be minimal if any affect from these activities.

Seismic, Exploration and Delineation Wells

Under Alternative B-1, there could be up to 11 seismic surveys, 5 exploration-focused and 6 production-focused for a total estimated short-term impact of 581,397 acres or 61,093 miles (See Table 4-11 on page 69) for surveying and camp train use under Alternative B-1. The surveys use low–ground-pressure vehicles to minimize potential impacts to the tundra. The typical survey lasts about 100 days. Seismic camps, which generally consist of six camp strings of five ski-mounted trailers, are typically moved every few days to once a week. On-shore seismic surveys on the North Slope are only collected in the winter. The activity would be temporary and disturbance lasts only while the survey or camp train is passing through.

Exploration drilling that has taken place since 1999 involved no more than two drill rigs active simultaneously in the Reserve in any given season. The estimated number of drill rigs per year under Alternative B-1 for exploration and delineation is two oil rigs and three gas rigs. While a rig could be used for multiple wells, each rig could only be used at one site at a time. Typically, drill rigs are removed from the Reserve at the end of the winter drilling season. Drilled wells are either plugged or capped for reentry at a later date. Approximately 768 acres would have short-term impacts from exploration and delineation wells under Alternative B-1. Recreation resources could be minimally impacted from the moving camps and associated noise from generators, aircraft, and human presence. The impact would be minimal, temporary, and confined to the immediate area.

Activities in the winter would be far less visible because of the limited daylight hours. Due to the remoteness and climate of the Reserve, and typical type and frequency of recreation use taking place in the winter, there would be minimal, if any, effect on recreation opportunities from these activities. However, the presence of oil and gas winter activity could be beneficial to recreationists in the case of an emergency as a means of communication and/or medical help.

Gravel Pads, Roads, and Airstrips

As part of production activities, an airstrip, camp facilities, and a storage yard could be needed. A borrow site from which to acquire gravel for pads, roads, and an airstrip may be a part of each production operation, but depending on the availability of gravel and the proximity of production operations, some borrow sites may provide gravel for multiple production operations. The only visible disturbance associated with gravel sites from borrow pits would generally only be stockpiled materials. While these sites could be large in size or footprint (about 37 acres each), very little material would remain as stockpile at any one time. Gravel mine sites from aboveground bedrock locations may produce scenic impacts if material is removed from rock outcrops within the planning area. Airstrips would usually be located near a central processing facility for transporting supplies and personnel to the field site.

While the intensity of impacts would be greatest during actual construction and development of the roads and pads, human presence and associated activity could have impacts on recreation resources during the life of the activity. Because production could occur for 10–50 years beyond the development phase, impacts would be long-term. Impacts would be greatest within 1 mile of a road, airstrip, or gravel site, and 2 miles of a pad. The estimated long-term disturbance for central processing facilities booster pump stations, compressor stations, and staging bases in Alternative B-1 is 490 acres. The greatest impacts to recreation resources would be within 2 miles of one of these sites. The estimated disturbance for in-field gravel roads, airstrips, gravel pads, and gravel pits in Alternative B-1 is 5,554 acres. At this time, it is not known what the layout of this infrastructure would be. Assuming all roads, pads, pits, and airstrips do not overlap with other infrastructure, a 1-mile impact zone for roads, airstrips, and gravel pits, a 2-mile impact zone for pads and associated facilities, the approximate total number of acres impacting recreation resources is 1,948,884 acres.

The relative proportion of the gravel roads, airstrips, and pads to the Reserve size is minimal. Once built, the infrastructure would be used year-round. Due to the climate of the Reserve, recreationists would be more likely to see the roads in the summer than winter. However, since this infrastructure would be a part of production activities, they would most likely be off limits to the public. Displacement of recreationists from these areas would adversely affect recreationists' experiences and desired beneficial outcome (i.e., hunting, camping, hiking, etc.) from use of the public lands. However, the degree of the effect would depend on the actual location of the infrastructure; generally infrastructure distant from routes of travel by recreationists would have little to no effect on recreationists.

The discovery and development of commercial fields is likely to occur gradually across the NPR-A. During production, there would be a production pad, which could potentially support dozens of wells and contain a large central processing facility for an oil field or a combined central processing facility and gas compressor facility for a gas field.

The central processing facility would typically include living quarters and offices, maintenance shops, storage tanks for fuel and water, power generators, waste-treatment units, a communications center, communication towers, aircraft towers and compressors for gas and water reinjection. They would be constructed as transportable modules, which would be supported above the ground on pilings to accommodate ground settling or frost heaving. Towers could be as high as 200 feet and well lit.

The oil and gas facilities, equipment, noise, night lighting, and human activity could alter the recreation setting to an industrial setting, which would interfere with recreationists' goals, and influence their opportunities, activities, experiences, and benefits. Recreation resources could be affected by possible displacement, if the activity were to take place at a site previously used for recreation. The actual effects would depend greatly on where development fields were located.

Pipelines

The production operation would include feeder lines, regional pipelines, booster pump (oil) or additional compression stations (gas), a high-pressure gas trunk line, a gas conditioning facility and an oil-sale and/or gas-sale pipeline to transport the resource to market. The actual locations of new pipelines in the NPR-A would depend on the location and sequence of commercial-sized discoveries. Aboveground pipelines for oil would be the preferred method, while gas pipelines would be underground.

Oil pipelines would create a minor visual impact to recreationists who happen to see them, for the length of time that they are in view. While gas pipelines would not be visible, vegetation over the gas pipelines would indicate their location. The dirt work involved with underground pipelines could leave a change in the vegetation (see section 4.4.5, "Vegetation") that would benefit recreationists by creating an easier walking area. Pipelines and associated human activity could alter the recreation setting to an industrial setting, which would interfere with recreationists' goals, and influence their opportunities, activities, experiences, and benefits. Once built, a pipeline would have a long-term impact on the area. Due to the climate of the Reserve and typical recreation activity and frequency in the winter, a pipeline would be more likely to be seen in the summer months than the winter months.

The estimated long-term disturbance (life of the project) for gathering or feeder lines, gas pipelines, and oil pipelines in Alternative B-1 is 1,461 acres, with 7,366 acres short-term disturbance. Short-term impacts would be minimal, temporary, and confined to the immediate area (i.e., within approximately one-half mile in any direction). Assuming a 1-mile impact zone on either side of pipelines the total long-term impacts to recreation resources from oil and gas pipelines would be approximately 1,788,160 acres.

4.4.16.3 Effectiveness of Stipulations and Best Management Practices

Although the lease stipulations and best management practices of Alternative B-1 do not specifically address recreation resources, many of the lease stipulations and best management practices of Alternative B-1 would serve to protect recreation resources such as Best Management Practices A-1 through A-7, A-9, B-1, B-2, C-4, E-6, E-7, E-8, and F-1, and Lease Stipulations D-1, E-2, E-3, K-1, and K-2. In addition, approximately 15.5 million acres would be classified as special areas, further protecting recreation resources in the Reserve. Table 2–3 in Volume 1, Chapter 2 has a description of the stipulations and best management practices. These lease stipulations and best management practices help protect recreation resources by protecting the natural environment and the resources that recreationists may be interested in such as fish, mammals, birds, vegetation, and water.

4.4.16.4 Conclusion

The impacts from activities not associated with oil and gas on recreation resources would be minimal, seasonal, confined to the immediate area, and present only during the activity for Alternative B-1. About 581,397 acres or 61,093 miles of seasonal impacts would be expected to be impacted short-term by seismic activities, 232,710 acres or 77,570 miles of short-term impacts by the construction of ice roads or airstrips and snow trails, and 768 acres by exploration and delineation wells as described in the oil and gas scenarios above. However, due to the remoteness and climate of the Reserve, and typical type and frequency of recreation use taking place in the winter, there would be minimal, if any, effect on recreation opportunity from these activities.

The approximate total number of acres impacting recreation from gravel pads, roads, and airstrips is 1,820,205 acres. Long-term impacts by drilling production, service wells and pipelines are approximately 1,916,843 acres (7,366 acres in the short term). These activities could displace recreationists, and thus, adversely affect their experiences and desired beneficial outcome from use of the public lands. However, the degree of the effect would depend on the actual location of the activities and their relationship to recreation opportunities. Pipelines, production activities, and associated human activity could alter the recreation setting to an industrial setting, which would interfere with recreationists' goals, and influence their opportunities, activities, experiences, and benefits.

The impacts on recreation resources would be similar for all alternatives. The biggest difference between the alternatives in relation to recreation resources is the total amount of activity that would take place under each alternative. Approximately 15.5 million acres would be designated special areas under Alternative B-1, further protecting recreation resources in the Reserve. The short-term acres impacting recreation resources are approximately 828,285 acres, seasonal 232,710 acres, and long-term 3,737,048 acres.

Long-term impacts associated with Alternative B-1 would impact the least amount of acres of recreation resources of all the alternatives. The southern portion of the NPR-A, which has traditionally had the most special recreation permit authorizations per year, would not be available for leasing under Alternative B-1.

As the climate gets warmer in the NPR-A (Scenarios Network for Alaska Planning 2010), the timing of recreation activities would change. Summer recreation activities could take place for a longer time period and winter activities for a shorter timeframe. Warmer and longer summers could increase the demand for recreation use of the area. Climate change could affect the caribou migration patterns, which would in turn change the location of guided special recreation permit activity taking place. According to the Scenarios Network for Alaska Planning fire map, there would be an increase in fires in the southern portion of NPR-A. The fires could displace special recreation permit permittees.

4.4.17 Wild and Scenic Rivers

During scoping for this IAP, 12 streams in the NPR-A were found to meet the minimum requirements for inclusion in the National Wild and Scenic Rivers System, and to lack up-to-date evaluation of their suitability for such designation. The 12 streams, all in the southern and southwestern NPR-A and not covered by the existing Northeast and Northwest NPR-A plans, are the Nigu, Etivluk, Ipnavik, Kuna, Kiligwa, Nuka, Utukok, Awuna, upper Colville, and Kokolik rivers and Driftwood and Carbon creeks. Each of these streams has outstandingly remarkable values, which were identified during scoping by the public and the planning team as described in section 3.4.7.3 (Volume 1, Chapter 3). The outstandingly remarkable values are: paleontological resources, recreation, wildlife habitat and wildlife viewing, scenery, cultural resources, and subsistence. Wild and Scenic Rivers should remain free flowing and unpolluted.

Under Alternative B-1, all 12 eligible rivers described in Chapter 3 would be found suitable and recommended for inclusion in the National Wild and Scenic Rivers System, to be managed as wild river areas. There would be 1,135 miles of river corridor that would be suitable and recommended in the National Wild and Scenic River System (Table 4-20 on page 322). The rivers would be managed with Visual Resource Management Class I, Class II, and Class III buffers. Permanent non-subsistence facilities allowed would be prohibited across all these rivers in the NPR-A, except across the lower portion of the Utukok, Kokolik, and Awuna rivers, which also would be the only portions of the eligible 12 rivers that would be available for leasing.

4.4.17.1 Activities Not Associated With Oil and Gas Exploration and Development

Free flow and Water Quality: The 12 eligible rivers would remain free flowing and free of pollution from impacts resulting from non-oil and gas activities would be the same as described for Alternative A because non-oil and gas activities would not be sufficient to cause noticeable impacts.

Outstandingly Remarkable Values: There are no impacts to outstandingly remarkable values identified for the 12 eligible rivers from non-oil and gas activities. Paleontological resources would continue to be studied and there is some chance that unauthorized removal of paleontological resources might occur at a similar level to the current situation. Studies impact a few square meters of surface, and resource theft, while it is known to occur, is uncommon, and law enforcement efforts in this area are thought to provide deterrence. Wildlife resources along the rivers might be disturbed to a very minor extent by recreational visitors and by aircraft. Recreational activity will likely continue at current levels. Recreational activities along the eligible rivers would not be noticeably impacted by other non-oil and gas activities in the area. Subsistence resources and access would not be impacted by non-oil and gas activities along the eligible streams. Scenery in the area would not be changed by non-oil and gas activities.

4.4.17.2 Oil and Gas Exploration and Development Activities

Under Alternative B-1, the lower portions of the Kokolik, Utukok, and Awuna rivers would be available for oil and gas leasing. The potential for exploration and development of oil and gas resources in these areas is relatively low.

Free flow, water quality, and outstandingly remarkable values: Under Alternative B-1, the 12 eligible rivers would be managed as wild river areas, and no water resources projects (i.e., projects that could potentially impact water quality or free flow) would be authorized by federal agencies unless such projects could be designed to protect and enhance free flow, water quality, and the outstandingly remarkable values of the designated stream segments. Aircraft overflights of eligible rivers might increase from oil and gas activities, and if this happens, there would be some impact to recreation and subsistence. Recreation experiences would be less primitive, and subsistence hunts could be disrupted by such overflights.

In Alternative B-1, 12 rivers are proposed for designation as wild river areas. In wild river areas the BLM manual (MS-6400 7.1) states:

> New roads are not generally compatible with this classification. A few existing roads leading to the boundary of the river corridor may be acceptable. New trail construction should generally be designed for nonmotorized uses. However, limited motorized uses that are compatible with identified values and unobtrusive trail bridges may be allowed. In order to protect and enhance river values, the BLM should consider restrictions or prohibitions of new airfields if such development is proposed.

It is unlikely but not impossible that a new road would be approved for construction across a designated wild river segment. Application of ANILCA title XI standards to any wild and scenic rivers in NPR-A could make it more likely a road could be approved. Aboveground powerlines would be more likely to be approved than roads and bridges. Wild river areas would allow buried utilities, including pipelines to be constructed so long as outstandingly remarkable values could be protected.

4.4.17.3 Effectiveness of Stipulations and Best Management Practices

Best Management Practices A-2 through A-7 reduce risks to water quality impairment through procedures for handling potential pollutants, preventing spills, and responding to spills. Setbacks in K-1 should be effective in reducing potential pollution and visual impacts to all eligible streams. In addition, Best Management Practice C-2 would protect stream banks from compaction and E-16 would prohibit removal of more than 100 cubic yards of sand or gravel from cliffs, and any extraction of sand or gravel near streams would require studies that would indicate there would be no potential impacts to the integrity of the river bluffs.

4.4.17.4 Conclusion

Under Alternative B-1 the majority of the watersheds of the 12 eligible streams would be unavailable for oil and gas development (see Table 4-20 on page 322), and the Wild and Scenic River corridors (encompassing all 12 streams) would be managed as Visual Resource Management Class I, with outer buffers managed as Visual Resource Management Class II or Class III, which would minimize impacts to scenic values from activities along the streams. There could be some limited impacts to wild river values of eligible rivers within the planning area as direct or indirect impacts of this alternative where uses do not require federal authorization or are not water resources projects. All 12 of the eligible streams would be proposed for inclusion in the National Wild and Scenic Rivers System as wild river areas.

Climate change might impact the vegetation and soils along the eligible streams, most noticeably by the intrusion of taller shrubs and thawing permafrost. This would impact the accessibility and scientific values of cultural sites by hiding them, and change the scenic quality of the areas viewable from the stream by limiting vistas. It is possible that melting permafrost could increase sedimentation and turbidity in these streams, reducing water quality.

4.4.18 Wilderness Characteristics

Alternative B-1 would allow leases to be offered for oil and gas exploration and development on 48 percent of NPR-A subsurface lands. Another 1.57 million acres would remain deferred from oil and gas leasing until 2014; and 425,000 deferred until 2018. There are 15.5 million acres that would be recognized as special areas (Teshekpuk Lake Special Area, Colville River Special Area, Utukok River Uplands Special Area, Kasegaluk Lagoon Special Area, and Peard Bay Special Area). Alternative B-1 would recommend twelve rivers be designated as Wild and Scenic Rivers.

4.4.18.1 Activities Not Associated with Oil and Gas Exploration and Development

Under Alternative B-1, the characteristics of wilderness could be affected in the same way as Alternative A from activities not associated with oil and gas exploration and development. Alternative B-1 emphasizes the protection of surface resources of the NPR-A and portions of the Reserve would be unavailable for leasing, neither of which would change the effects of activities not associated with oil and gas as compared to Alternative A.

4.4.18.2 Oil and Gas Exploration and Development Activities

Seismic Surveys

Under Alternative B-1, there could be up to 11 seismic surveys, 5 exploration-focused and 6 production-focused, for a total estimated short-term disturbance of 581,400 acres (see Table 4-11 on page 69) for surveying and camp train use under Alternative B-1. The surveys use low-ground-pressure vehicles to minimize potential impacts to the tundra. The typical survey lasts about 100 days. Seismic camps, which generally consist of six camp strings of five ski-mounted trailers, are typically moved every few days to once a week. Wilderness characteristics of naturalness, outstanding opportunities for solitude or primitive and unconfined recreation, and scenic values could be minimally impacted from the moving camps and associated noise from generators, aircraft, and human presence. The impact would be minimal, temporary, and confined to the immediate area (i.e., within approximately 0.5 mile in any direction).

A longer lasting impact could be to vegetation resulting from seismic survey operations (see section 4.4.5) impacting naturalness and scenic values. The color contrast would be minimal from ground view and almost nonexistent from more than a few hundred feet away. After 8 to 9 years, the evidence of use would be minimal. Seismic operations by their nature do not follow the same routes every year and the number of miles of survey line run can vary greatly from year to year.

Ice Roads, Pads, Airstrips and Snow Trails

Ice roads, pads, airstrips, and snow trails are temporary in nature and traversed during the winter months. Ice roads provide seasonal routes for heavy equipment supplies, and movement of personnel to remote staging areas or well locations. Ice airstrips are used to transport crews and supplies to and from sites. Snow trails provide seasonal routes for use by low-ground pressure vehicles and used for moving equipment, supplies, personnel accommodations, and drill rigs capable of disassembly to components small enough for transport on such vehicles. The estimated total seasonal acres disturbed by ice roads, ice pads, airstrips, and snow trails are 232,710 acres. The wilderness characteristics of naturalness and solitude or primitive and unconfined recreation could be minimally impacted from the associated noise from generators, aircraft, and human presence. The impact would be minimal, temporary, and confined to the immediate area (i.e., within approximately 0.5 mile in any direction).

Exploration and Delineation Wells

Exploration drilling since 1999 involved no more than two drill rigs active simultaneously in the Reserve in any given season. The estimated number of drill rigs per year under Alternative B-1 for exploration/delineation is two oil rigs and three gas rigs. While a rig could be used for multiple wells each rig could only be used at one site at a time. Typically, drill rigs are removed from the Reserve at the end of the winter drilling season. Drilled wells are either plugged or capped for reentry at a later date. Approximately 768 acres would have short-term disturbance from exploration and delineation wells under Alternative B-1. Wilderness characteristics of naturalness and outstanding opportunities for solitude or primitive and unconfined recreation could be minimally impacted from the associated noise from generators, vehicles, and human presence. The impact would be minimal, temporary, and confined to the immediate area (i.e., within approximately 0.5 mile in any direction). For well sites that are capped, a wellhead would remain on site. Due to the remoteness and expansiveness of the Reserve, a capped wellhead would not impact wilderness characteristics.

Gravel Pads, Roads, and Airstrips

As part of production activities an airstrip, camp facilities, and a storage yard could be needed. A borrow site from which to acquire gravel for pads, roads, and an airstrip may be a part of each production operation, but depending on the availability of gravel and the proximity of production operations, some borrow sites may provide gravel for multiple production operations. The only visible disturbance associated with gravel sites from borrow pits would generally only be stockpiled materials. While these sites could be large in size or footprint (about 37 acres each), very little material would remain as stockpile at any one time. Gravel mine sites from aboveground bedrock locations may produce visual impacts if material is removed from rock outcrops within the planning area. Airstrips would usually be located near a central processing facility for transport of supplies and personnel to the field site.

While the intensity of impacts would be greatest during actual construction and development of these facilities, remaining structures (i.e., roads, pads, airstrips), human presence, and associated activity and noise all would have impacts on wilderness characteristics during the life of the activity. Because production could occur for 10 to 50 years beyond the development phase, impacts to wilderness characteristics of naturalness, outstanding opportunities for solitude or primitive and unconfined recreation, and scenic supplemental values would be long term. Impacts would be greatest within 1 mile of a road, airstrip, or gravel site, and 2 miles of a production pad. The estimated long-term disturbance for central processing facilities booster pump stations, compressor stations and staging bases in Alternative B-1 is 490 acres. The greatest impacts to wilderness characteristics would be within 2 miles of one of these sites. The estimated usage for in-field gravel roads, airstrips, gravel pads, and gravel pits in Alternative B-1 is 5,554 acres. At this time, it is not known what the layout of this infrastructure would be. Assuming all roads, pads, pits and airstrips do not overlap with other infrastructure; a 1-mile impact zone for roads, airstrips, and gravel pits; a 2-mile impact zone for pads and associated facilities; the approximate total number of acres impacting wilderness characteristics is 1,820,205 acres. The BLM can require removal of gravel roads/pads/airstrips after the life of the activity, or could decide to allow them to remain forever, which would have a permanent impact on wilderness character. If these activities impair wilderness characteristics in the future, the areas would be excluded from the inventory of lands with wilderness characteristics.

The discovery and development of commercial fields is likely to occur gradually across the NPR-A. During production there would be a production pad, which could potentially support dozens of wells and contain a large central processing facility for an oil field or a combined central processing facility/gas compressor facility for a gas field.

The central processing facility would typically include living quarters and offices, maintenance shops, storage tanks for fuel and water, power generators, waste-treatment units, a communications center, communications towers, aircraft towers and compressors for gas and water reinjection. They would be constructed as transportable modules, which would be supported above the ground on pilings to accommodate ground settling or frost heaving. Communication towers could be as high as 200 feet and well lit.

Pipelines

The production operation would include feeder lines, regional pipelines, booster pump (oil) or additional compression stations (gas), a high pressure gas trunk line, a gas conditioning facility and an a oil-sale and/or gas-sale pipeline to transport the resource to market. The actual locations of new pipelines in NPR-A would depend on the location and sequence of commercial-sized discoveries. Aboveground pipelines for oil would be the preferred method while gas pipelines would be underground. Because production could occur for 10 to 50 years beyond the development phase, impacts to wilderness characteristics of naturalness, outstanding opportunities for solitude or primitive and unconfined recreation, and scenic supplemental values would be long term. The estimated long-term disturbance from gathering/feeder lines, gas pipelines, and oil pipelines in Alternative B-1 is 1,461 acres, with 7,366 acres short-term use. Short-term impacts would be minimal, temporary, and confined to the immediate area (i.e., within approximately 0.5 mile in any direction). Assuming a
1-mile impact zone on either side of pipelines) the total long-term impacts to wilderness characteristics from oil and gas pipelines would be approximately 1,788,160 acres. If these activities impair wilderness characteristics in the future, the areas would be excluded from the inventory of lands with wilderness characteristics.

4.4.18.3 Effectiveness of Stipulations and Best Management Practices

Although the lease stipulations and best management practices do not specifically address wilderness characteristics and BLM is not considering recommending designation of wilderness in the planning area, many of the standards required for development of Alternative B-1 would serve to protect wilderness characteristics including best management practices A-1through A-7, B-2, C-2, C-3, E-1, E-4, E-13, and F-1,and lease stipulations D-1, D-2, G-1. In addition, approximately 15.5 million acres would be classified as special areas, further protecting wilderness characteristics in the Reserve. Table 2–3 in Volume 1, Chapter 2 has a description of the stipulations and required operating procedures/best management practices. These lease stipulations and best management practices help protect wilderness characteristics by protecting the natural environment and resources such as fish, mammals, birds, vegetation, and water.

4.4.18.4 Conclusion

The impacts from activities not associated with oil and gas on wilderness characteristics from Alternative B-1 would be minimal, confined to the immediate area, and for the most part concurrent with activities. Total short-term acres for Alternative B-1 as described in the oil and gas scenarios for seismic activities would be 581,400 acres. However, there may be evidence of the seismic activity for 8 to 9 years. About 232,710 acres is expected to be impacted by the construction of ice roads, ice pads, airstrips, and snow trails and 768 acres by exploration and delineation wells as described in the oil and gas scenarios above. The impact would be minimal, temporary, and confined to the immediate area.

The approximate total number of acres impacting wilderness characteristics from gravel pads, roads, and airstrips is 1,820,205 acres. Long-term impacts by drilling production, service wells, and pipelines are approximately 1,916,843 acres (7,366 acres short term). If these activities impair wilderness characteristics in the future the areas would be excluded from the inventory of lands with wilderness characteristics.

Disturbance from long-term, seasonal and short-term actions could potentially impact approximately 4.8 million of the NPR-A's nearly 23 million acres in a manner that could impair wilderness characteristics. Of the remaining 18.2 million acres in the NPR-A, 15.5 million acres of lands with wilderness characteristics would be protected by special designation or by being unavailable for leasing and development. The balance of the lands with wilderness characteristics, 2.7 million acres, would not have measures taken to specifically protect lands with wilderness characteristics, but are not anticipated to be subject to actions that would cause wilderness characteristics to be lost.

The impacts on wilderness characteristics would be similar for all alternatives. The biggest difference between the alternatives in relation to wilderness characteristics is the total amount of activity that would take place under each alternative. Alternative B-1 would have the least percentage of long-term impacts on wilderness characteristics along with the lowest acreage of winter short-term use.

The supplemental values than an area may contain of ecological, geological, or other features of scientific, education, scenic, or historical value may be affected if the climate continues to warm in the NPR-A (Scenarios Network for Alaska Planning 2010). See climate sections within the Physical Environment and Biological Resources sections of Chapter 3 for more information.

4.4.19 Visual Resources

Under Alternative B-1, the 12 rivers (Colville, Nigu, Etivluk, Ipnavik, Kuna, Kiligwa, Nuka, Awuna, Kokolik, and Utukok rivers and Driftwater and Carbon creeks) recommended for designation as Wild and Scenic Rivers would be classified as Visual Resource Management Class I (3 percent of NPR-A). The objective of this class is to preserve or retain the existing character of the landscape. The Teshekpuk Lake and Wainwright Inlet and lands in the southern foothills area more than 0.5 mile and less than 5 miles from 11 rivers recommended as Wild and Scenic Rivers (Map 2-5) would be classified Class II (16 percent of NPR-A). The objective of this class is to retain the existing character of the landscape. Lands beyond the 5 miles from the Class II boundaries would be classified as Class III (31 percent of NPR-A) along with rivers and lands (not designated Class I or II) within 3 miles of segments of rivers identified as eligible for Wild and Scenic Rivers designation in this IAP, the 2003 Northwest NPR-A IAP, or the 2008 Northeast NPR-A Supplemental IAP; also Kasegaluk Lagoon, Peard Bay, Elson Lagoon, Dease Inlet, and Admiralty Bay and lands within 3 miles of those waterbodies. This class would generally allow change to occur. The remainder of the planning would be designated Class IV (50 percent of NPR-A). The levels of change allowed for this class can be high.

4.4.19.1 Activities Not Associated with Oil and Gas Exploration and Development

Under Alternative B-1, visual resources could be affected in the same way as Alternative A from activities not associated with oil and gas exploration and development. Alternative B-1 emphasizes the protection of surface resources of the NPR-A and makes portions of the Reserve unavailable for leasing, neither of which would change the effects of activities not associated with oil and gas as compared to Alternative A.

4.4.19.2 Oil and Gas Exploration and Development Activities

Seismic Surveys

Under Alternative B-1, there could up to 11 seismic surveys, 5 exploration-focused and 6 production-focused, for a total of 581,400 acres impacted by surveying and camp train use. The surveys use low-ground-pressure vehicles to minimize potential impacts to the tundra. The typical survey lasts about 100 days. Seismic camps, which generally consist of six camp strings of five ski-mounted trailers, are typically moved every few days to once a week.

On-shore seismic surveys on the North Slope are only collected in the winter, and therefore the colors of structures and equipment would have a weak contrast with the white color of the snow-covered landscape. In Visual Resource Management terms, the definition of weak is: The element contrast can be seen, but does not attract attention (H-8431-1). Activities in the winter would be far less visible due to the limited daylight hours, although lights on equipment would be visible when the equipment is passing through an area. Due to the remoteness and climate of the Reserve, the casual observer would not likely be present to be affected visually by the seismic activity. Local subsistence users could be traveling on the tundra and observe the seismic activity (see section 4.4.13). Visual resources could be minimally impacted from the moving camps, aircraft, and human presence.

The seismic operations would have a moderate contrast to the landscape character element of line. In Visual Resource Management terms, the definition of moderate is: "The element contrast begins to attract attention and begins to dominate the characteristic landscape" (H-8431-1). The seismic equipment would represent a bold line on a large mass of continuous white.

A longer lasting visual impact could be to vegetation resulting from seismic survey operations (see section 4.4.5). Because trails visually modify existing vegetation, they would not produce much contrast to line, form, or texture. The color contrast would be minimal from ground view and almost nonexistent from more than a few hundred feet away. After 8 to 9 years, the evidence of use would be minimal. Seismic operations by their nature do not follow the same routes every year and the number of miles of survey line run can vary greatly from year to year.

Ice Roads, Pads, Airstrips, and Snow Trails

Ice roads, pads, airstrips, and snow trails are temporary in nature and traversed during the winter months. Ice roads provide seasonal routes for heavy equipment supplies, and personnel accommodations moving to remote staging areas or well locations. Ice airstrips are used to transport crews and supplies to and from sites. Snow trails provide seasonal routes for use by low-ground-pressure vehicles and used for moving equipment, supplies, personnel accommodations, and drill rigs capable of disassembly to components small enough for transport on such vehicles.

Activities in the winter would be far less visible due to the limited daylight hours, although lights on equipment would be visible when the equipment is passing through an area. Due to the remoteness and climate of the Reserve the casual observer would not likely be present to be affected visually by this activity. Local subsistence users could be traveling on the tundra and observe the activity (see section 4.4.13). Visual resources could be minimally impacted from the moving camps, aircraft, and human presence. The estimated total seasonal acres impacted by ice roads, ice pads, airstrips, and snow trails are 232,710 acres.

Exploration and Delineation Wells

Exploration and delineation wells are typically drilled in the winter in the Reserve. Exploration drilling that has taken place since 1999 involved no more than two drill rigs active simultaneously in the Reserve in any given season. The estimated number of drill rigs per year under Alternative B-1 for exploration/delineation is two oil rigs and three gas rigs. While a rig could be used for multiple wells, each rig could only be used at one site at a time. Typically, drill rigs are removed from the Reserve at the end of the winter drilling season. Drilled wells are either plugged or capped for reentry at a later date. Capped wells have a pipe, which would likely be less than 6 feet tall and surrounded by a short fence 6 feet square. The pipe could be a long-term impact, but would be almost unnoticeable from several hundred feet away. Approximately 768 acres would have short-term impacts from exploration and delineation wells under Alternative B-1.

Activities in the winter would be far less visible due to the limited daylight hours, although lights on equipment would be visible when the equipment is passing through an area. Due to the remoteness and climate of the Reserve the casual observer would not likely be present to be affected visually by this activity. Local subsistence users could be traveling on the tundra and observe the activity (see section 4.4.13). Visual resources could be minimally impacted from the moving camps, aircraft, and human presence.

Gravel Pads, Roads, and Airstrips

As part of production activities, an airstrip, roads, camp facilities, and a storage yard could be needed. A borrow site from which to acquire gravel for pads, roads, and an airstrip may be a part of each production operation, but depending on the availability of gravel and the proximity of production operations, some borrow sites may provide gravel for multiple production operations. The only visible disturbance associated with gravel sites from borrow pits would generally only be stockpiled materials. While these sites could be large in size or footprint (about 37 acres), very little material would remain as stockpile at any one time. Gravel mine sites in the NPR-A from aboveground bedrock locations may produce visual impacts if material is removed from rock outcrops. This mining activity would change the form of the natural landscape and may be visible from the Foreground-Middleground Zone. Airstrips would usually be located near a central processing facility for transport of supplies and personnel to the field site.

While the intensity of impacts would be greatest during actual construction and development of the roads and pads, human presence, and associated activity could also have impacts on visual resources during the life of the activity. The landscape of the Reserve is homogeneous, without a lot of visual variety and contrast. Therefore, building a road would be expected to cause a weak amount of contrast to the form of the land. It would minimally impact the landscape character element of line through introduction of the location and road, both of which would be visible linear features. Exposing the soil would cause a weak impact to the color in the landscape. The texture of the exposed soil would be smoother than the existing landscape, thus creating a weak contrast. When an application is received for a road, a visual contrast rating would be completed to determine the actual contrast, along with a visual simulation and mitigation measures would be determined to maintain the appropriate Visual Resource Management class.

Because production could occur for 10 to 50 years beyond the development phase, impacts would be both short term and long term. These impacts would be greatest within 1 mile of a site. The estimated use for in-field gravel roads, airstrips, gravel pits, and gravel pads in Alternative B-1 is 5,554 acres. The estimated long-term use for central processing facilities booster pump stations, compressor stations and staging bases in Alternative B-1 is 490 acres. The greatest impacts to visual resources would be within 2 miles of one of these sites. At this time, it is not known what the layout of this infrastructure would be. Assuming all roads, pads, pits and airstrips do not overlap with other infrastructure, a 1-mile impact zone for roads, airstrips, and gravel pits, a 2-mile impact zone for pads and associated facilities, the approximate total number of acres impacting visual resources is 1,916,843 acres (see Table 4-14 on page 76).

The relative proportion of the roads, airstrips, and pads to the Reserve size is minimal. Once built, they would be used year-round. Due to the climate of the Reserve, the casual observer would be more likely to be in the Reserve to see the roads in the summer than winter. The impact associated with the graveled pads and roads would be moderate, long term, and confined to the 1- and 2-mile impact zones.

The discovery and development of commercial fields is likely to occur gradually across the NPR-A. During production, there would be a production pad, which could potentially support dozens of wells and contain a large central processing facility for an oil field or a combined central processing facility/gas compressor facility for a gas field.

The central processing facility would typically include living quarters and offices, maintenance shops, storage tanks for fuel and water, power generators, waste-treatment units, a communications center, communication towers, aircraft towers and compressors for gas and water reinjection. They would be constructed as transportable modules, which would be supported above the ground on pilings to accommodate ground settling or frost heaving. Communication towers could be as high as 200 feet and well lit.

The blocky, rectangular form of the structures would contrast strongly with the existing landscape. In Visual Resource Management terms, the definition of strongly is: The element contrast demands attention, will not be overlooked, and is dominant in the landscape (H-8431-1). They would introduce distinct vertical lines, which would strongly contrast with the existing horizontal landscape. The smooth texture of the structures would strongly contrast with the coarser texture of the surrounding vegetation. Potential impact would include artificial light and associated sky glow from winter drilling. This lighting would degrade scenic quality by introducing intrusive, artificial lighting into an otherwise unlit natural landscape that would be visible from a distance of approximately 17 miles (based on a 200 feet tall tower calculated mathematically).

Visual resources would be moderately impacted long term, and confined to the area of view. The actual effects would depend greatly on where development fields were located.

Pipelines

The production operation would include feeder lines, regional pipelines, booster pump (oil) or additional compression stations (gas), a high-pressure gas trunk line, a gas conditioning facility, and an oil-sale and/or gas-sale pipeline to transport the resource to market. The actual locations of new pipelines in the NPR-A would depend on the location and sequence of commercial-sized discoveries. Aboveground pipelines for oil would be the preferred method while gas pipelines would be underground.

Building a pipeline would cause a strong amount of contrast to the form of the land. It would moderately impact the landscape character element of line through introduction of the location and pipeline, both of which would be visible linear features. Exposing the soil would cause a weak impact to the color in the landscape. The texture of the exposed soil would be smoother than the existing landscape, thus creating a weak contrast. Once the pipeline is built it would have a moderate contrast with the form of the land. The NPR-A has many lakes of various sizes and shapes. A pipeline crossing the lakes would create a moderate contrast. The color contrast would depend on the color of the pipeline. Assuming the pipeline is grayish silver, there could be a moderate contrast with the colors in the landscape. The texture of the pipeline would be smooth compared to the existing landscape.

Once built, a pipeline would have a long-term impact on the area, being more visible in the summer months than the winter months. The estimated long-term disturbance for gathering/feeder lines, gas pipelines, and oil pipelines in Alternative B-1 is 1,461 miles, with 7,366 miles short-term use. Assuming a 1-mile impact zone on either side of pipelines, the total long-term impacts to visual resources from oil and gas pipelines would be approximately 1,788,160 acres. Visual resources would be moderately impacted long term, but confined to the immediate area. The actual effects would depend greatly on where development fields were located.

4.4.19.3 Effectiveness of Stipulations and Best Management Practices

Although the lease stipulations and best management practices do not specifically address visual resources, many of the standards required for development of Alternative B-1 would serve to protect visual resources including A-1 through A-7, C-2, C-3, E-1, E-5, and E-15, and lease stipulations D-1, D-2, and G-1, by regulating overland moves, seismic work, exploratory drilling, facility design, construction and siting of facilities, water use, minimize impacts to solid and hazardous waste, minimize contaminants and the protection of stream banks. In addition, approximately 15.5 million acres would be classified as special areas under Alternative B-1, further protecting visual resources in the Reserve. Table 2–3 in Volume 1 has a description of the stipulations and best management practices. These lease stipulations and best management practices help protect visual resources by protecting the natural environment and resources such as fish, mammals, birds, vegetation, and water.

4.4.19.4 Conclusion

Under Alternative B-1, the impacts from activities not associated with oil and gas on visual resources would be minimal, confined to the immediate area, and for the most part concurrent with activities. About 581,400 acres is expected to be impacted by seismic activities, which for the most part would be minimal, temporary, and confined to the immediate area. However, there may be evidence of the seismic activity for 8 to 9 years. About 232,710 acres is expected to be impacted by the construction of ice roads, ice pads, airstrips, and snow trails, and 768 acres by exploration and delineation wells as described in the oil and gas scenarios above. The impacts of the construction of ice roads/ airstrips and snow trails, drilling of exploration and delineation wells, would be minimal, temporary, and confined to the immediate area.

The approximate total number of acres impacting visual resources from gravel pads, roads, and airstrips is 1,820,205 acres. Long-term impacts by drilling production, service wells and pipelines are approximately 1,916,8431 acres, 7,759 acres in the short term.

The impact to visual resources from gravel pads, roads and drilling production, service wells and pipelines would be moderate long term, and confined to the 1- and 2-mile impact zones. When an application is received for these kinds of activities a visual simulation will be conducted for the NEPA analysis for each project, which will determine the actual impact expected. A visual contrast rating would also be completed and mitigation measures would be determined to maintain the appropriate Visual Resource Management class.

Climate change could affect visual resource values by altering the current conditions of color, vegetation, adjacent scenery, and the presence of water. Shifts in public sensitivity could occur as well. The biggest difference between the alternatives is the total amount of activity that affects visual resources, because all the alternatives would have similar types of impacts. Alternative B-1 would offer the least amount of lands for oil and gas leasing. Disturbance from long-term, seasonal, and short-term actions could potentially impact visual resources on approximately 4.8 million of the NPR-A's nearly 23 million acres. Approximately 15.5 million acres would be included in Special Areas under Alternative B-1, further protecting visual resources in the Reserve. Alternative B-1 would have the least percentage both short-term and long-term visual effects along with the lowest acreage of winter short-term use of all the alternatives. The acres impacted with this alternative are the least of any alternative. The Visual Resource Management classes determined in Alternative B-1 would create more lands in Class I, less Class II, less Class III, and more Class IV than the visual resources inventory. Table 4-21 on page 329 provides a comparative analysis between the percent of the acres of inventory class versus the percent of the acres of Visual Resource Management classes.

4.4.19.5 Potential New Mitigation Measure (New Best Management Practice)

The objective and requirement/standard would be the same as those described in section 4.3.19.5. The potential benefits and residual/unavoidable impacts would be similar to those described for Alternative A at section 4.3.19.5, yet within the context of the different Visual Resource Management classes designated in this alternative.

4.4.20 Economy

4.4.20.1 Activities Not Associated with Oil and Gas Exploration and Development

Impacts of non-oil and gas activities are likely to be the same as those for Alternative A. The BLM estimates (Table 4-1) of trips and number of participants remains the same. Employment is expected to remain the same, largely occurring outside the North Slope Borough. Special recreation permit revenues are expected to remain the same as Alternative A, at a minimum of $600 per year.

Other activities such as research or surveys, various ground activities, and aircraft use not related to petroleum are shown in Table 4-1, and those related to offshore petroleum are discussed later in section 4.2.1.1. North Slope Borough residents may be employed in some of these activities, as will other Alaskans and non-residents. It is possible that less research will occur as the result of less stress to targeted species and areas by oil and gas activities and possible budget constraints within the federal government in the coming decade. The lower revenues (see section 4.4.20.2) for State and local government may result in fewer field activities within the NPR-A, as well.

4.4.20.2 Oil and Gas Exploration and Development Activities

In Alternative B-1, activities will begin and proceed in a manner and order similar to Alternative A. Discovered resources in the Mooses Tooth and Bear Tooth units and at Umiat will be unchanged from Alternative A. Peak production for the undiscovered resources in this alternative is calculated at 38 thousand barrels of oil per day for oil and 1.2 billion cubic feet per day for gas. Oil production will contribute to maintain the Trans-Alaska Pipeline System throughput above threshold for about 2 years at peak production, assuming a 270,000 barrels per day threshold and a 6 percent production decline rate. Up to 8 oil and 19 gas processing facilities will be in operation during the life of the undiscovered fields.

Revenues

Revenues are lower than in other alternatives except B-2, as the result of the smaller amount of undiscovered resources available for development. Bonus bids generated in leasing may total as much as $90 million, reflecting an anticipated lower level of leasing in available northwestern areas because of the surface occupancy (pipeline) limitations in the Teshekpuk and Utukok River Special Areas. Exploration, development, and production activities for the undiscovered resources are estimated to generate property tax revenue to the North Slope Borough of about $2 billion over the period. Other local, State, and federal revenues are also anticipated to be less under this alternative than under Alternative A. The estimated royalty payment shared equally by the State of Alaska and the federal government is $9 billion. State corporation taxes will be $0.9 billion, and federal income tax will be $7.4 billion. In addition, State production taxes are estimated to total $4 billion. These estimates are based upon prices of $180 per barrel of oil and $8.67 per thousand cubic feet of gas, as explained in section 4.2.1.

Total revenue data, including discovered and undiscovered resources, are presented in Table 4-25. Local, State, and federal government revenues total $35.4 billion for all the activities, and would average $1.2 billion if all occurrences are developed simultaneously.

Table 4-25. Alternative B-1 revenues (in millions of 2010 dollars)

	North Slope Borough		State of Alaska		Federal	
	Total	**Average annual***	**Total**	**Average annual***	**Total**	**Average annual***
Bonus bids**			45	1.5	45	1.5
Royalty			6,617	235.5	6,617	235.5
Property tax	2,543	90.0	283	10.0		
Corporate income tax			1,180	41.0	9,909	344.0
Production tax			8,205	285.0		
Totals	**2,543**	**90.0**	**16,330**	**573.0**	**16,571**	**581.0**

* If all projects occur simultaneously.

** Over next 30 years.

Employment

In this alternative, employment related to the undiscovered resources will be lower than in other alternatives, as the result of less oil and gas development. For the undiscovered scenario, 8 oil and 19 gas processing facilities would be constructed, with fewer wells drilled and fewer miles of pipeline constructed than in the other alternatives. Table 4-26 presents new and continued employment estimates for both discovered and undiscovered oil and gas activities.

Table 4-26. Potential employment under Alternative B-1

Potential Employment	Alternative total	Annual average
Total for all places of residence	407,869	8,967
Direct	171,160	3,703
Indirect & Induced	236,709	5,264
North Slope Borough total	14,951	357
Direct	8,125	193
Indirect & Induced	6,826	167
Other Alaska total	320,855	7,027
Direct	120,245	2,585
Indirect & Induced	200,610	4,442
Outside Alaska total	72,425	1,583
Direct	42,791	925
Indirect & Induced	29,634	658

Other Effects of Oil and Gas Development

Under Alternative B-1, if health problems arise due to air or water pollution, or increased stress or other pathologies described in section 3.4.12, "Public Health" (Volume 1), there would be increased economic costs both for individuals and government associated with concerns such as health care, social services, and law enforcement. These costs will be less than under other alternatives.

Development under Alternative B-1 could also contribute to some increase in the cost of engaging in subsistence activities. Costs would include fuel, supplies, equipment, and additional time, particularly as travel is increased. These costs would be less than under other alternatives.

Alternative B-1 is not likely to affect the cost of fuel or supplies for villages resulting from the operation of ice roads. The chief executive officer of Kuukpik Corporation stated he could not see changes in economies resulting from the operation of ice roads. (Chinn 2007) Unless there is a gravel road connecting Nuiqsut or other North Slope villages to the state's road network, which is not anticipated as part of this IAP/EIS, it is unlikely that costs would change significantly.

With the possible exception of services related to health, social services, and law enforcement noted above, public infrastructure costs, including schools and local airports, are not likely to be affected by development under Alternative B-1. North Slope oil fields are largely self-sufficient for emergency services and health and social services. For example, oil facilities typically include emergency medical technicians, clinical facilities, and emergency transportation. Air traffic from oil and gas development will be directed toward oil field airstrips, not community airports. Local tax revenues will be lower, which may limit the Borough's ability to maintain some infrastructure or provide some services, depending on other revenue sources.

4.4.20.3 Conclusion

Employment and governmental revenues generated by oil and gas exploration and development would be lower in Alternative B-1 than under other alternatives. Oil and gas exploration and development would benefit the local, State, and national economy by increasing revenues and employment. Nearly $36 billion would flow to all levels of government. There would be $16.6 billion for the federal government, $16.3 billion for the State of Alaska and $2.5 billion for the North Slope Borough. The number of jobs created by exploration, development, and production would total 407,869 direct and indirect over the life of all projects. An average of 357 North Slope Borough resident jobs would be added or continued if discovered and undiscovered resources were developed simultaneously. Increased costs to harvest subsistence resources could affect the economic well-being of North Slope Borough residents, primarily through increased costs to reach subsistence resources, but this effect would be the lowest of all alternatives.

4.4.21 Public Health

4.4.21.1 Activities Not Associated with Oil and Gas Exploration and Development

The activities not associated with oil and gas exploration and development are described in section 4.2.1.1 and include aircraft use, river trips and other recreational uses, site cleanup and remediation activities, overland moves, archeological surveys and site work. The level of such activity will be the same under Alternative B-1 as it is under Alternative A.

Such activities should not have a significant impact on public health. Localized impacts on subsistence are likely, primarily as a result of displacement of animals due to aircraft noise. In addition, the presence of temporary camps may affect subsistence regardless of whether they cause displacement of animals, as a result of the avoidance of the area by hunters seeking to minimize conflict. These impacts are described in section 4.3.1.3. The effect of such activities is likely to be localized and temporary.

Alterations in the success of subsistence activities can impact health by way of nutritional outcomes and risk of injury. The mechanisms of these effects are described in section 4.3.21.2. For any individual affected, the impact of an unsuccessful hunt or an accident or injury on the land could be severe. However, given the transient and highly localized nature of these activities, it is unlikely that they will have any overall impact on public health.

4.4.21.2 Oil and Gas Exploration and Development Activities

The oil and gas exploration activities described in section 4.2.1.2 may lead to alterations in public health and safety via a number of different pathways. These include diet and nutrition, environmental exposures, infectious disease, safety, acculturative stress, economic impacts, and capacity of local health care services. For details of these pathways and a description of how they impact health, see section 4.3.21.2. The potential impacts of Alternative B-1 on each pathway are described below.

Diet and Nutrition

The likelihood of impacts to subsistence harvests under Alternative B-1 is discussed in section 4.4.13. As is the case with Alternative A, Nuiqsut, Atqasuk, and Barrow would be the most heavily impacted communities, as these villages obtain most of their non-marine traditional food from the affected lands. Wainwright and Anaktuvuk Pass will be affected to a lesser degree, as they depend somewhat on fish and caribou harvested from potentially affected areas within the NPR-A. Any reductions in the success of the harvests of these species in any village would accelerate the transition from subsistence resources to store-bought foods, worsening nutritional outcomes and food insecurity. The protection of a large area of surface resources under Alternative B-1, including calving and insect-relief areas for the Western Arctic Caribou Herd, will help protect subsistence activity and will reduce the likelihood and severity of these health impacts.

Nuiqsut hunters, who already avoid large areas of traditional land to the northeast of the village, could experience further limitation in their access to lands to the south and west of the village if further development occurs in the vicinity of the village. Avoidance of productive land may reduce harvests and exacerbate dietary and nutritional outcomes independent of any direct impact on the animals themselves. Making large amounts of productive land to the northwest of Nuiqsut unavailable for leasing and forbidding permanent non-subsistence infrastructure there, however, makes the likelihood of such outcomes less likely in Alternative B-1.

Environmental Exposures

Health effects from environmental exposures under Alternative B-1 will follow the same pathways as for Alternative A, described in section 4.3.21. The overall impact of air quality on human health is likely to remain low. However, people who are particularly vulnerable to respiratory problems (such as children, the elderly, and people with certain chronic illnesses) may experience health problems at locations or during episodes with poorer air quality. Water contamination from runoff, spills or discharges is unlikely to cause health effects under Alternative B-1. However, if water contamination reaches a drinking water supply for residences or people on the land, acute or chronic health effects may ensue, depending on the nature of the contaminant and the level and duration of exposure. In absence of a major accidental release, contaminant levels in traditional foods are likely to remain below levels that would trigger public health concern. Environmental noise may cause annoyance or sleep disturbance for those who experience it; this is most likely to be people on the land or in cabins who are affected by helicopter traffic or overflights.

Insofar as Alternative B-1 limits development across a significant portion of the NPR-A and limits conflict between subsistence and industrial uses of the land, both real and perceived environmental exposures are likely to be lower with this alternative than with Alternatives A, C, and D, and similar to B-2. Intermittent exposure is possible in areas where development and subsistence use overlap. Permanent facilities in close proximity to villages may episodically affect air quality and are likely to undermine confidence in the safety of traditional foods.

Infectious Disease

Under Alternative B-1, as with Alternative A, a continued in-migration of oil industry workers from communities outside of the North Slope will present a risk of infectious disease transmission. The character and extent of this impact will be the same for all alternatives, varying only to the degree to which individual project characteristics increase the number of outside workers and the degree to which they fraternize with the local population. The nature of this impact is described in section 4.4.21.2.

Safety

Safety impacts under Alternative B-1 will be similar to those for Alternative A. The main impact on safety will result from local alterations in travel patterns for subsistence activity. Noise from overflights in any area of exploration or development will cause temporary displacement of caribou and birds, and may require hunters to travel farther from their camps and cabins. These impacts will be localized and temporary, but may intermittently impact a large number of users of the land. The protection of a large amount of land under Alternative B-1 will reduce this impact for many hunters from Barrow, Atqasuk, and Nuiqsut.

Under all alternatives, any further development of fixed facilities in areas of traditional use is likely to result in voluntary displacement of subsistence. Given the current impact of Alpine on the land use patterns of Nuiqsut hunters, any further development in close proximity to that community will substantially increase their travel distances and the subsequent risk of injury.

Acculturative Stress

Under Alternative B-1, as with Alternative A, the current trends in acculturation and its subsequent health impacts are likely to continue. The protection of a larger amount of surface resources under Alternative B-1 will help maintain subsistence and other traditional uses of the land in all communities, and will slow the rate of acculturation and subsequent health impacts.

Under all alternatives, the isolation of outside workers into segregated work camps and the low levels of direct Iñupiat employment in the oil and gas industry will continue to provide some protection against acculturative stress. Villages where industrial activity occurs in close proximity will be at greatest risk, particularly if there is more open access between the local population and the work camps.

Economic Impacts

Health impacts from economic conditions are likely to be similar under all alternatives. Revenue to the North Slope Borough, and village corporations will allow for the continued funding of existing health and social programs and the preservation of the current high level of indirect employment. New jobs in the oil and gas sector will continue to be created, though too few will go to Iñupiat workers to create any local health benefit. Increases in alcohol, drug use, and sexually transmitted infections will be expected, commensurate with the level of economic growth and the degree of contact between outside workers and local populations. Less intense development under Alternative B-1 will partially reduce the negative impact of rapid economic growth on public health.

Health Care Services

The impact on health care services under Alternative B-1 will be largely the same as under Alternative A (see section 4.3.21.2). Tax revenues from ongoing exploration and development will support the continued provision of the current level of health care services in the North Slope Borough, and should not significantly impact demand. Increased occurrences of injury and trauma (see safety, above) will be sporadic and will be well within the capacity of acute care and search and rescue services in Barrow. The likelihood of an increase in demand for health care services under Alternative B-1 is low. The lower intensity of development under Alternative B-1, however, may both decrease year-to-year revenue and lead to an earlier decline in oil and gas production in the region. These impacts are described in section 4.4.20. Although budgetary constraints for health care services are possible, it is unlikely that these will result in significant changes in public health.

4.4.21.3 Effectiveness of Stipulations and Best Management Practices

The management actions described in section 2.2 and the stipulations and best management practices described in section 2.8 (both in Volume 1) provide a number of important protections for public health and safety.

Public Health Consultation, which is provided as a management action, and the Healthy Neighbor Policy (see section 2.7 in Volume 1) both recognize the importance of proper consideration of public health impacts, and engagement with local health stakeholder organizations to plan for avoiding, minimizing, and mitigating potential health harms and—where possible—enhancing health benefits. As many of the public health impacts of oil and gas development will be project-specific, such management actions are crucial.

The specific stipulations and best management practices that will directly work to protect or promote public health and safety are listed under Alternative A in section 4.3.21.3. These include:

Measures Affecting Diet and Nutrition

- A1-11: Waste Prevention, Handling, Disposal, Spills and Public Safety.
- E-1, E-7: Facility Design and Construction
- H1-H3: Subsistence Consultation for Permitted Activities. Note that H3 is included in Alternative B-1, but not Alternative A.

Measures Affecting Environmental Exposure

- A1-11: Waste Prevention, Handling, Disposal, Spills and Public Safety.

Measures Affecting Infectious Disease

- A1-11: Waste Prevention, Handling, Disposal, Spills and Public Safety.
- I-1: Orientation Programs Associated With Permitted Activities.

Measures Affecting Safety

- A1-11: Waste Prevention, Handling, Disposal, Spills and Public Safety.

Measures Affecting Acculturative Stress

- E-13: Facility Design and Construction.

Measures Affecting Economic Impacts on Health

- I-1: Orientation Programs Associated With Permitted Activities.

When considering the effectiveness of stipulations in mitigating public health effects, it must be recognized that because the Iñupiat people continue to value this land deeply as a foundation of well-being and culture, any stipulation that contributes to minimizing the environmental impacts of development and preserving and promoting traditional uses of the land can be seen as contributing positively toward overall well-being and public health.

Taken in whole, the stipulations provide for important provisions that will directly and indirectly promote public health and safety during oil and gas development activities, and partially mitigate some of the adverse health pathways anticipated under Alternative B-1.

4.4.21.4 Conclusion

Under Alternative B-1, the pattern of health impacts is likely to be similar to Alternative A. The transition in the burden of disease from one in which infectious disease predominated to one in which chronic disease is the primary driver of ill-health will progress among the Iñupiat as it has in other indigenous populations. As is the case with other subsistence-dependent Arctic regions, injuries and trauma will continue to carry a disproportionate share of morbidity and mortality when compared to the general Alaska and U.S. populations, and the risk of injury and trauma may also be exacerbated if climate change results in unusual or unpredictable weather, water, snow, and ice conditions that make travel more hazardous (Brubaker 2011), and dislocation of subsistence species require people to travel greater distances to find marine or land mammals or edible plants.

Oil and gas activities contribute to these trends and impact public health in a number of ways. The preservation and promotion of traditional uses of the land is a public health priority, both for the nutritional benefits associated with a subsistence diet and for the social cohesion and cultural value associated with traditional Iñupiat practices. Though economic development provides important health benefits through both individual employment and revenues to local governments, these benefits are balanced against the risks that result from an erosion of traditional culture and diet, and exposure to environmental contaminants, social ills, and infectious disease. The focus on the protection of surface resources under Alternative B-1 will help preserve subsistence uses of the land and prevent erosion of traditional Iñupiat culture and diet.

Under Alternative B-1, as is the case with all alternatives, localized exploration activity will create transient impacts on subsistence by way of diversion of hunters and animals. In addition, noise from air traffic and other sources will create a nuisance around individuals' camps and cabins. Fewer hunters will be affected by such impacts under Alternative B-1, due to the larger area of heavily frequented land in the northeast of the NPR-A which will be unavailable for leasing. Potential contamination of food and surface water is possible, though measurable public health impacts resulting from such contamination are unlikely under normal operating conditions. Less conflict between development and subsistence use under Alternative B-1 will further minimize the likelihood of environmental contamination, and should reduce the likelihood of an exacerbation in the currently high levels of perceived contamination in the region.

Fixed production sites, particularly those in the vicinity of villages and in areas of heavy subsistence use of the land, will have an impact on public health under Alternative B-1. The avoidance of developed areas by hunters increases travel times and costs associated with subsistence activity, and as a result, will potentially decrease harvests and increase the risk of injury and accidents while on the land. Episodes of poor air quality associated with dust or emissions will pose a health hazard for at-risk populations such as those suffering from chronic obstructive pulmonary disease or asthma. The land-use framework under Alternative B-1 reduces the number of locations where such conflicts will occur.

The economic impact of activity under Alternative B-1 may result in some reductions in funding and difficulty maintaining the current levels of services and indirect employment, particularly through the North Slope Borough. It is unlikely that budgetary constraints will have a significant impact on public health. Employment for the Iñupiat in the oil and gas sector will not be significant enough to create any positive public health impacts. The health risks associated with economic growth and in-migration, namely increased use and access to alcohol and drugs and the spread of infectious disease and sexually transmitted diseases will be commensurate with the level of employment, road access, and the degree to which outside workers fraternize with local populations. As with all alternatives, the continued focus on the development of isolated work camps will temper these impacts. The lower overall level of activity under Alternative B-1 will further minimize the negative impacts of in-migration and economic growth.

4.4.21.5 Potential New Mitigation Measures (new best management practice)

The objective and requirement/standard for all potential new public health mitigation measures would be the same as those described in section 4.3.21.5. The potential benefits and residual/unavoidable impacts would be similar to those described for Alternative A at section 4.3.21.5.

and should reduce the likelihood of an exacerbation of [illegible] high levels of [illegible] contamination in the region.

Fixed production sites, particularly those in the vicinity of villages and in areas of heavy subsistence use of the land, will have an impact on public health under Alternative B-1. The avoidance of developed areas by hunters increases travel times and costs associated with subsistence activity, and as a result, will potentially decrease harvests and increase the risk of injury and accidents while on the land. Emissions of poor air quality associated with dust or emissions will pose a health hazard for at-risk populations such as those suffering from chronic obstructive pulmonary disease or asthma. The land use framework under Alternative B-1 reduces the number of locations where such conflicts will occur.

The economic impact of activity under Alternative B-1 may result in some reductions in funding and difficulty in sustaining the current levels of services and indirect employment, particularly through the North Slope Borough. It is unlikely that budgetary constraints will have a significant impact on public health. Employment for the Inupiat in the oil and gas sector will not be significant enough to create any positive public health impacts. The health risks associated with economic growth and in-migration, namely increased access to alcohol and drugs and the spread of infectious disease and sexually transmitted diseases will be commensurate with the level of employment of non-residents and non-locals, which entails worker interaction with local populations. As with all alternatives, the continued focus on the development of isolated work camps will isolate these impacts. The lower overall level of activity under Alternative B-1 will further minimize the potential impacts of in-migration and economic growth.

4.4.27.5 Potential New Mitigation Measures (new best management practices)

The objectives and requirements intended for all potential new mitigation measures would be the same as those described in section 4.3.21.5. The potential benefits and residual impacts would be similar to those described for Alternative A-1 in section 4.3.21.5.

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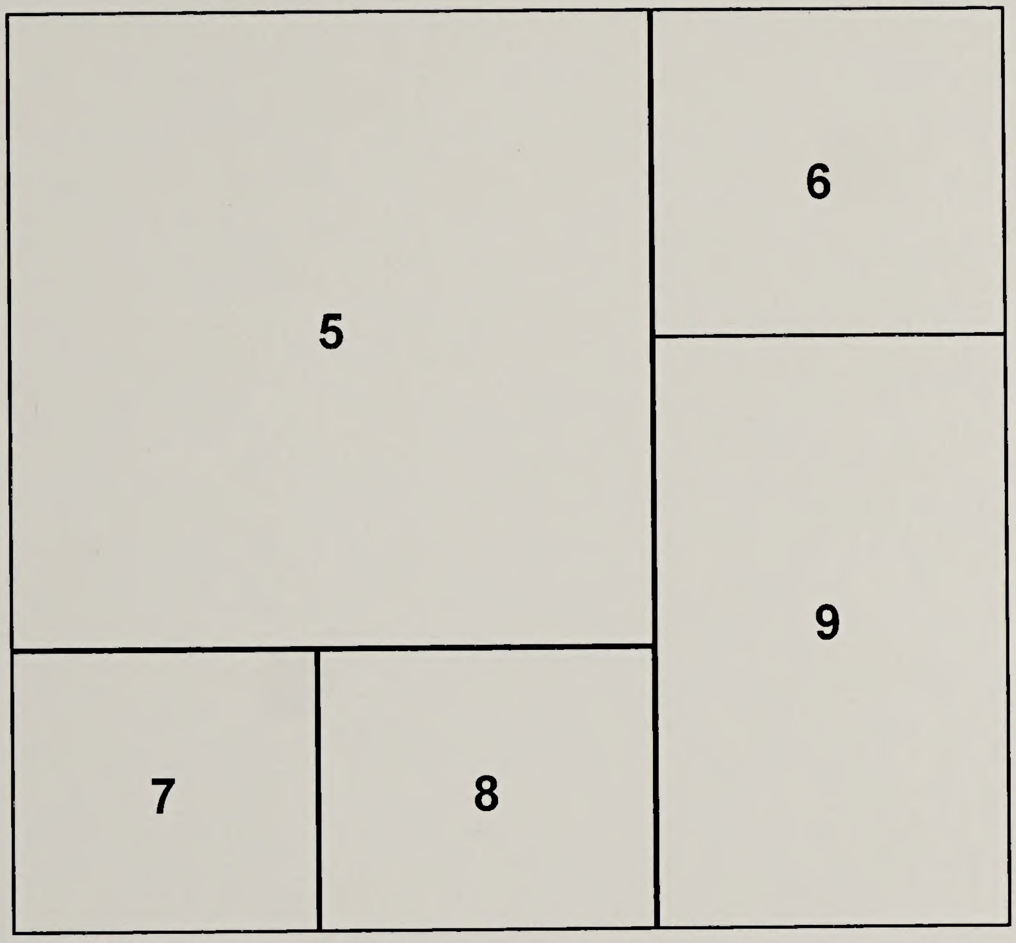

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